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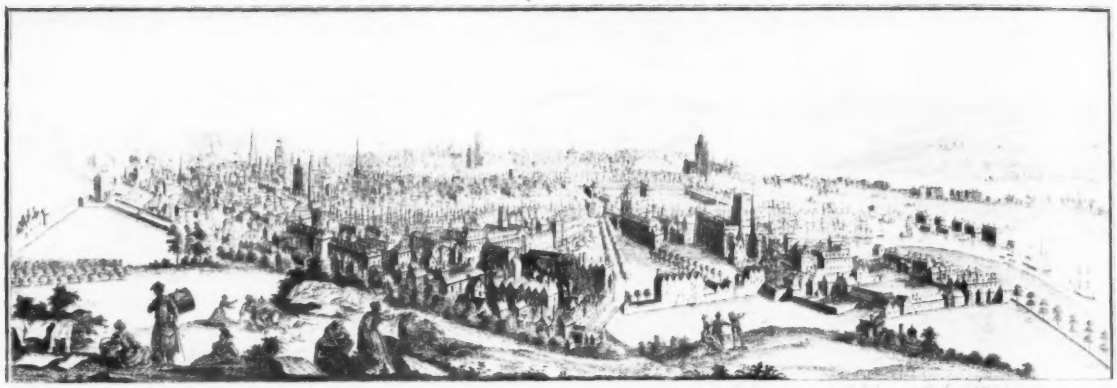
CONTENTS FOR 27 JUNE 1938

THE NORTH WEST PROSPECT OF THE CITY OF BRISTOL.



Bristol, 1734, from the engraving by S. & N. Buck

JOURNAL OF THE
ROYAL INSTITUTE *of* BRITISH ARCHITECTS

VOL. 45. 3RD SERIES 27 JUNE 1938 No. 16

Journal

A.R.P.

The importance of the R.I.B.A. Conference on Structural Precautions against air-raids is enough to justify the allocation of almost the whole of this number of the JOURNAL to the report of the proceedings. To meet immediate demands for the report, an extra number is being printed, but we hope that it will be possible to reprint the whole report as a pamphlet, detached from the other JOURNAL contents. Members who want copies of the reprint for themselves, their clients, or for their local authorities are asked to let us know *soon* how many copies they will want. The price, which has not yet been fixed, will probably be 1s. 6d. (1s. 9d. post free), with reduced prices for orders of twelve or more copies.

Readers of this JOURNAL who, when they turn the page, will find fifty-two pages of instruction and discussion on air-raid precautions, must not be dismayed at its length, and they must certainly not think that they can fulfil their duty by reading merely the report of the inaugural meeting: that was an introduction only to the lectures by Mr. Scott and Mr. Bird on the two following days, and the discussions they provoked. All the more valuable—if less polemical—information will be found there. There had been plenty of surmise as to the course which the Conference would take, which varied from the anticipations of those who hoped that Mr. Scott and Mr. Bird would be able to provide some specific precaution or impregnable shelter to the depressed rejection of any action by those whose natural resistance to what everyone admits to be an unpleasant subject had not been broken down. There is no harm in repeating here what was constantly said by Mr. Scott and Mr. Bird in the course of their remarks. Their task was to state the measures that could be adopted to provide a reasonable degree of security in existing and new structures without adopting defensive construction and planning of a kind that would fundamentally change or impede peace-time use. This was made entirely clear at the inaugural meeting, and was endorsed again and again during the instructional course; no one who listened to the lectures will be in any doubt about it, or will have other than admiration for the way in which Mr. Scott and Mr. Bird fulfilled their task. The fact that they made no attempt, and quite rightly, to go beyond their brief to discuss what means should be taken to provide safety for citizens who cannot be defended by "structural precautions" on existing dwellings does not relieve us from the moral and professional obligation to concern ourselves, in so far as we can do so usefully, with the enormous problem of the protection of the great majority of the inhabitants of any large industrial city who live in terrace houses, overcrowded on the city plan, and overcrowded by their inhabitants. We, as architects, may not live in Shadwell, Stepney, West Ham, or Shoreditch, or the comparable districts of large provincial cities, but we cannot be unaware of the problems that the homes of those who do live there present to the people who have to provide defence against aerial attack. Our suburban homes at twelve houses to the acre, or even our larger and better built terraces in the West End, with one family only to each house, provide a hardly comparable problem, taking into consideration the greater means of wealthier families to look after themselves by home-made protection or flight.

This is not an easy business—it is so difficult that the obvious escape from attempting to solve it is to say glibly that it is not our business at all. It is quite obvious that it cannot be solved in the terms of the precautions considered at the Conference—as Mr. Bird said clearly. Furthermore, what is the good of "dispersal" in an area like the East End of London, which has no space free in which to distribute a population jammed tight already in insecure dwellings without even cellars to give the illusion of security?—a certain and enviable target for any ruthless enemy. What can be done to evacuate a population of several millions along roads incapable even of taking a Bank holiday crowd with speed and safety? Large community shelters are, we are told, impracticable for various reasons; if that is so then it must be numberless small shelters, and their design is surely a matter in which the profession can play its part. This was not discussed at the Conference. That may have been good because it was outside the

plan of the Conference, but we cannot allow it to be forgotten or delude ourselves that the manner in which the homes of about three-quarters of our people are to be defended is of no concern to us as architects.

A.R.P. and the Allied Societies

In reading the report, members should bear in mind that the movement it represents was inspired by the Government. The Home Office requested the R.I.B.A. to take on the task of disseminating technical knowledge of Structural A.R.P. on their behalf; accordingly, in taking on this task, the R.I.B.A. has planned a series of A.R.P. Conferences all over the country, especially in "potential target areas," under the ægis of the R.I.B.A. Allied Societies. Each Allied Society and Branch or Chapter was invited to send a representative to the London Conference, and as a result many are already taking steps to organise conferences in their principal towns. Two have already been definitely fixed—in Leeds and Birmingham—to take place in July. The services of the two London lecturers are available to Allied Societies without charge.

At the Home Office's request, these conferences are to be open to all registered architects, and local authorities are to be invited to send as representatives one or more architecturally trained members of their staffs. Thus this work is not merely an internal domestic affair but the biggest task ever laid on the R.I.B.A. or the profession by the Government of this country, and it is up to us to carry it out to the very best of our ability. If it is well done there can be no question that the status of the architectural profession in the eyes of the Government and of the public will be greatly enhanced.

Visit to the Building Research Station

The Science Committee's visit to the Building Research Station was quite the most successful they have organised. More than fifty members attended, the day was fine, and the organisation, as usual, excellent. Since it is always impossible for a new visitor to obtain at all a clear mental picture of the work of the Station unless he is prepared to spend at least a couple of days there, the programme was wisely limited to a few select items of current interest.

The party first assembled in the recently erected recreation room (Architects, H.M.O.W.), where they saw a film on continental rendering methods. In common with the Forest Products Research Laboratory, the B.R.S. is now taking to the use of films as a means of publishing their work, in particular, processes and craftsmanship, for which it is the most suitable medium. To say, for instance, that the continental plasterer throws the rendering mixture on to the wall gives but a poor mental impression, compared with that given by film, of the skill and accuracy with which this is done.

Groups were then formed, who proceeded in turn to inspect the work in progress on sound transmission and some experiments on the penetration of driving rain. The former included full-scale tests on a wooden joisted floor. In these tests the procedure has been to erect a structural floor, and then submit to standard tests a great variety of cushioning devices on the top and suspended ceilings below. Work was started some months ago on a hollow tile floor, and this has now been concluded. Tests, also full scale, on sound transmission problems in a steel-framed building were also inspected. This work on sound transmission is one of the most valuable on which the Station is engaged and publication of results will be a matter of some importance to architects and the building industry.

After tea a simple apparatus for measuring the dryness of plaster was demonstrated. This should be of value on building works where "speed is the essence of the contract," since it will say with certainty when it will be safe to apply paint. At the end of the proceedings a vote of thanks to the Director and staff, proposed by Mr. Walter Goodesmith [*A.*], Hon. Secretary of the Science Committee, was carried with acclamation.

Journal Draughtsman Post Vacant

A post as draughtsman on the R.I.B.A. Journal staff will become vacant in the middle of July. The draughtsman is not expected to have had experience in the particular work of preparing drawings for reproduction, but any such experience is valuable. The job is an interesting one, bringing its holder into contact with all types of architectural work and methods of draughtsmanship, and it gives experience which is certain to prove valuable later. The salary offered is £4 10s. a week and applications should be sent to the Editor at the Institute by 2 July.

A Presentation to Mr. H. M. Fletcher

At the Council Dinner Club on Monday 20 June Mr. H. M. Fletcher was presented with an address and a shagreen and silver cigarette box as a tribute to his service as Honorary Secretary during the past four years.

Birthday Honours

In addition to the honours noted in the last number of the Journal, Lieut.-Col. G. Whittaker [*F.*] has been given the O.B.E., and Mr. A. R. Myers [*A.*] has been given the I.S.O.

Election Results

The Council election results are printed on page 834. The discussion at the informal general meeting on 20 June will be published in the next number.

CONFERENCE ON STRUCTURAL AIR RAID PRECAUTIONS

HELD AT THE R.I.B.A. ON 13, 14 & 15 JUNE 1938

INAUGURAL MEETING

HELD AT THE R.I.B.A. ON MONDAY, 13 JUNE 1938

MR. H. S. GOODHART-RENDEL, PRESIDENT, IN THE CHAIR

The PRESIDENT: This is a most momentous evening, and is also likely to be a long one because a great deal of interest may arise in the discussion we hope will take place. I had prepared a few introductory remarks I might have made, but I saw in the advance copy of Mr. Thomas Scott's paper that he had introduced nearly all my points, so my task is merely to introduce the speakers and to get out of the way.

We as architects enormously appreciate the honour that is put on us in having this Conference recognised officially as a fountain of information that is very much needed. We hope that the reports of this Conference when published will be very valuable to architects and to the public generally. I will now ask Sir Samuel Hoare, the Secretary of State for Home Affairs, to address the meeting.

The Rt. Hon. Sir SAMUEL HOARE (Secretary of State for Home Affairs): I congratulate your Institute upon this pioneer work. This is the first time in the history of any country that there has been summoned a conference of this kind to deal with this very urgent and important question. So far as I know, British architects are the first of their profession in any part of the world to gather together, as they have this evening, to discuss the best means of dealing with a new danger.

It seems to me that you who follow the profession of architecture are acting in full harmony with the traditions of your calling. I suppose that on looking back over the history and the achievements of the past, there are few fields in which architects have shown their genius more conspicuously than in the field of defence. You will fill in from your own experience your own examples of the works of defence in which architects have shown their capacity; I think myself of examples such as the Norman fortresses in the Middle East, and we must all think of a great fortified city like Carcassonne. We think again instinctively of those wonderful Venetian fortifications in the Mediterranean and in the Levant, and perhaps most of all we think of one of the greatest exponents of the French genius, the architect Vauban, and the impressive and arresting work that he did upon so many of the fortified posts of France.

It is strictly in accordance with the traditions of your profession that once again you should be taking an interest in this problem of defence and fortification, but what a sad commentary upon the history of the world and upon the vanity of human wishes that now for the first time in England since, I suppose, the end of the fifteenth century we are beginning to think once again about the fortification of private houses!

Whilst grieving at the course that the world has taken in these recent times, and whilst hoping that once again the arts of domestic life will return to more normal courses, we are faced with this difficult problem, and you, as experts in your profession, are gathered together to consider how best to deal with it. It seems to me that the problem, if I may put it in a single sentence, is to provide protection against the dangers of air raids for your clients as cheaply as ever you can. The more I see of this problem of air raid precautions the more I am convinced that we have to deal with it with common sense and with a feeling for realities. We cannot attempt the ideal; we have to improvise, we have very often to devise makeshifts, but, even so, I believe that we shall find that if we put our minds together we shall be able to devise makeshifts that will help us to avoid, supposing there was an air attack, panic on the one hand and unnecessary loss of life upon the other.

We are approaching this problem in the same spirit in which we almost always approach problems of this kind. Other countries adopt a different attitude towards problems of this kind. Perhaps it is that their minds are more logical than ours; perhaps it is that they have been more used to directions from the Government in the centre; but here in England we are approaching the problem first of all in the spirit of voluntary effort, and secondly, in the spirit of appealing

to groups of people in the country and to individuals to do what they can to help themselves. Accordingly I come to you to-night as Home Secretary, the Minister primarily responsible for air raid precautions, not to impose directions and conditions upon the whole country, as would be the case in certain of the other countries of Europe, but to ask you, the experts in this particular branch of air raid precaution work, to give me your help, and to place at the disposal of the country and of your clients the expert knowledge that you possess better than anyone else in the country. As I say, we are attempting to deal with this problem in sections ; we are attempting to deal with it upon the basis of voluntary effort, of an appeal to everybody in the country to help us with his particular knowledge and experience.

I am glad to think that now and for some time past your Institute has been giving the Home Office invaluable assistance. We have had, as you know, for more than a year a series of inquiries going on into this difficult problem of structural precautions, and we have had in particular a committee, upon which your Institute has been represented and upon which has also been represented The Institution of Civil Engineers. As a result of their work and of the expert assistance which has been given to us by such members of your Institute as the two gentlemen who are going to address us this evening, we hope to issue in the near future a detailed handbook upon structural protection. We hope very much that it will have a wide circulation, and we believe that it will be of great assistance in helping architects and the general public to deal not only with the problem of new buildings but also with the more difficult problem of the adaptation of existing buildings. We are proposing in the course of the next day or two to supplement this handbook with another handbook dealing with the difficult problem of the structural protection of hospitals. We have already dealt with the problem of police headquarters, and we hope with your help, in the course of the comparatively near future, to cover the whole field and to enable every part of the country to know the kind of precautions that ought to be taken and which can reasonably be taken without a prohibitive expenditure of money.

Do not let us be drawn into the mood of thinking that nothing can be done unless countless millions of money, public and private, are spent upon this problem. We believe that with expert advice a great deal can be done in the way of structural protection, in the way of building shelters, in the way of adapting old buildings, and particularly in the way of designing new buildings that will afford at no excessive expense the kind of protection that we and the other countries of Europe have in mind.

The kind of protection that we have in mind is not complete protection against the direct hit of a high explosive bomb. So far as I know there is no country in Europe that believes that it is possible to cover a country with protection of that kind. But we believe—and this is also the belief in Germany and in France—that it is possible to obtain protection against the blast and splinters of the high explosive bomb exploding at no great distance, and that it is possible to obtain that protection without the kind of astronomical expenditure that would be necessary to safeguard the country and individuals from a direct hit. It is interesting to note that that is the standard of protection which, so far as I know, all the countries in Europe that are engaged upon this problem of air raid protection are attempting to obtain.

So far as the Government is concerned, I am very glad to see that we have here to-night a representative of the Office of Works, who will tell you that we are attempting to apply that standard to Government buildings, whether they be existing Government buildings or whether they be new Government buildings.

In view of the urgency of this problem, it is indeed a satisfactory aspect that you here should be meeting together in this Conference, at which are represented architects from local authorities, from your own Institute, from neighbouring boroughs, from the London County Council and from the City Corporation, considering this problem very directly from the angle of London, perhaps the most difficult point over the whole field of the problem. I understand that you are going to follow up the Conference by a number of regional conferences over the whole country. I do indeed thank you for these efforts. I can assure you that they will be of very great value, not only to the Government, but to the country as a whole. I am told that you are going to follow them up with the appointment of regional advisers, who can give expert advice in the various regions of the country. All that kind of work is of very great value, and it is urgently needed.

We at the Home Office have in recent weeks been dealing with certain other sides of the problem—the problem of the recruiting of personnel for air raid precautions, and so on—and now with your help we have to concentrate upon this other side of the problem, no less important—some people would say even more important—namely, the problem of structural protection. I can assure you that without your help we should find it impossible to deal successfully or adequately with the many difficulties that the problem undoubtedly contains. On that account I am very glad to be here to-night at your opening meeting, and to thank you for the interest which you are taking in this problem. I wish you every success in dealing with this great new difficulty in the life of the country, and I express the hope that you will find an answer to the question of how best to give this protection at the least possible cost to your clients. I wish your Conference every success, and I thank you for the help that you are giving to the country.

AIR RAID PRECAUTIONS AS A PROBLEM FOR THE ARCHITECT

By THOMAS E. SCOTT [F.]

It was about three years ago that this Institute was invited to consider Air Raid Precautions in buildings: this invitation was received with very mixed feelings. It was, perhaps, inevitable that we whose professional instinct is the embodiment in building of those qualities which make for health, pleasure and efficiency should view with alarm this new factor which appeared to be so diametrically opposed to the ideals, not only of architecture, but of the whole of progressive civilisation.

For many of us the technical issues were obscured by moral indignation and religious and political convictions; those who were able to view the problem dispassionately were faced with apparently insuperable problems of construction if they were successfully to combat the hideous and tremendous forces of air attack as depicted by the popular Press.

I am neither competent nor willing to debate the political or other views which you, as citizens, are entitled to hold; indeed, this is not the place or time to do so, but I hope to be able to convince you that this problem, which the abuse of science has created for us, is one which architects can and must face: it may be unwholesome but it is real! I go further and insist that it is the architect's duty to the nation, of which he is a servant, to study this problem in its technical aspects, regardless of his personal views.

You will forgive me if I appear to regard war as a foregone conclusion: I do not, but war is an essential hypothesis to this unfortunate problem.

It is not necessary for me to speculate upon the effectiveness of our Air Force and the anti-aircraft services as the first line of defence against air attack: nor need I attempt to explain the many activities of the Air Raid Precautions Department. All these we may regard as adequate, but the most difficult problem of all would appear to be that of providing protection for the civilian population against the attack of such enemy aircraft as evade the first line of defence.

The deliberate bombing of civilians is an act of war which all sane people must view with horror: but horror is no excuse for refusing to recognise now as a possibility, something which may one day become a ghastly reality.

One thing appears certain, that as far as possible such measures as we may consider necessary and practicable must be undertaken as peace-time precautions, and not merely envisaged as emergency measures to be carried out if and when the need should arise. Even with the whole of the country's resources of labour and material available for passive defence, it would be impossible to achieve more than insignificant results in the time available between a threat of war and the opening of hostilities.

I am not going to propose that we, as architects, should at once direct our energies towards the construction of vast bomb-proof shelters; nor am I able to offer spectacular recommendations which will enable you to render buildings and their occupants immune to the effects of air attack; but I do suggest most definitely that you may have it in your power to design and construct buildings which will afford their occupants at least a substantial measure of safety, and buildings which, themselves, will the better withstand the effects of air attack.

This problem of structural precautions has engaged the very earnest attention of the Structural Precautions Committee for the last three years, and as one of your representatives privileged to take part in the work of that committee, might I at once state my conviction that precautions of a really effective nature may be introduced, as a new and permanent factor in the design and construction of buildings, without detriment to their artistic quality and efficiency.

The devising of some form of protection in existing buildings is a more difficult problem: it will involve the application of certain principles of structural precautions to the selection and adaptation of buildings suitable for this purpose, and, as such, is a duty which the architect is the best qualified man to undertake.

We have been able on the committee to study the effects of the aerial bombardment of towns in Spain and China and we have been afforded some opportunity of examining the results of research which has been carried out in this country.

I hesitate to criticise the efforts of harassed Government departments, but I owe it to my

colleagues on the Structural Precautions Committee and to a profession which directs building work to the value of two hundred million pounds every year to state my conviction that this research has not yet been given the full attention it deserves. I do not anticipate that research will enable us to devise some dramatic or easy means of resisting the destructive effects of high-explosive bombs; in point of fact, it is my opinion that the best results are to be achieved by wise planning rather than by scientific calculation; but I am convinced that if an adequate amount of properly considered research were undertaken it would be possible to speak with certainty on some details of structural precautions, which are now founded upon probability.

We have, however, reached conclusion on many important principles capable of being applied to the design of most classes of buildings: I hope these words will reach the ears of all responsible authorities, and that they will be compelled by public opinion to realise that buildings erected without due regard to structural precautions against air attack represents a wasted opportunity and in many cases a downright neglect of public duty.

I trust I shall not weary those who have a wide knowledge of this subject if I recite briefly some few details about the bombs which may be used by the air forces of to-day.

An air attack may be carried out with three main types of bomb: incendiary, gas and high-explosive.

Incendiary bombs, although a potential source of considerable danger to property, to the nation's stores and to the various public services, are probably less serious in themselves as a menace to human life. Most modern buildings of steel and concrete construction would probably be safe against the incendiary effects of these bombs, but buildings of a domestic type, particularly in densely built-up areas, might suffer considerable damage unless adequate fire-fighting services were available.

For all ordinary purposes the normal practice of fire-resisting construction should suffice, but special precautions will have to be undertaken in the case of stores of highly inflammable goods and in districts like the London Docks.

The gas bomb is certainly a more fearsome weapon, but used alone I do not think it would constitute a really serious danger, except to individuals actually incapacitated by the bursting bomb. It is my personal opinion that a large-scale gas attack is unlikely, but in any case, if gas bombs were used as the only form of attack, almost complete immunity would be secured by those occupying a gas-proof room, with the gas-mask as the second line of defence.

But there can be no certainty that incendiary and gas bombs will be used independently, and we are compelled to assume that an intelligent enemy would use one or both in conjunction with high-explosive bombs. This would not only have the effect of hampering the work of rescue parties, but it might also be the means of damaging or destroying such gas-excluding devices as could be adopted in ordinary buildings.

It is evident that the chief consideration must be given to protection against high-explosive bombs, and herein lies the most difficult problem we have to face.

High-explosive bombs may vary from 25 lbs. to 3,000 lbs. in weight: the size most likely to be used against buildings is the 500-lb. bomb. Bombs may be dropped from aircraft flying from heights of 5,000 ft. to 20,000 ft., or even higher, and the angle at which a bomb arrives will naturally vary according to the height and speed of aircraft from which it is dropped. There is a certain amount of doubt about the penetrative power of high-explosive bombs: it is considered by competent authorities that five feet of reinforced concrete may be required to resist the penetration of certain types of 500-lb. bomb and a further ten feet may be necessary to afford complete protection against the resultant explosion.

Imagine the force of impact of such a bomb dropped from a height of, perhaps, 15,000 ft. and you will then realise that no ordinary building could withstand the effects of a direct hit.

The indirect or secondary effects of high-explosive bombs are those of fragmentation and blast pressure. The fragments or splinters from a bursting bomb fly in all directions at great velocity. Thirteen-and-a-half-inch brick walls or 12-in. concrete walls will afford the standard of protection we have adopted, that is, against splinters from a 500-lb. bomb bursting 50 ft. away.

The blast or air pressure generated by a high-explosive bomb is of considerable magnitude, but of very short duration: this pressure is followed by a suction wave, which sometimes appears to be more destructive than the initial blast. There is still considerable uncertainty about the exact effect of blast upon buildings, but we have reason to believe that except in extreme cases, well-con-

structed buildings will not suffer more than superficial damage from bombs bursting externally. It is, of course, a different story when bombs burst inside a building, but a well-constructed steel or reinforced concrete framed building, with thin wall panels, would be less liable to serious or complete demolition than one having solid load-bearing walls.

One of the most serious consequences of the bombardment of buildings is that of demolition : reports from Spain indicate that a very considerable proportion of casualties have been caused by the collapse of the upper parts of buildings upon people sheltering in basements ; that is to say, in basements the floors over which are not sufficiently strong to withstand the additional load. Here, at any rate, we have one understandable problem of structural precautions and it needs no great ingenuity or skill to plan and construct shelter accommodation within buildings which would at least afford protection against the effects of demolition.

You will, perhaps, have observed that the structural precautions against the various effects of high-explosive bombs are of a somewhat contradictory nature. Thick walls are necessary to afford protection for personnel against splinters and blast, but in order to minimise the destructive effect of blast pressure upon buildings it is considered desirable that they should be constructed as framed structures, with thin walls which would yield to blast pressure without transmitting damaging stresses to the structural framework. Add to these varying requirements the uncertainty as to the size of bombs, their angle of arrival and force of impact and visualise the many possible points of impact of a bomb and you have some idea of the complexity of the problem. You, as architects, will have to solve the problems peculiar to your buildings, and in order that you may do this, the Structural Precautions Committee have worked towards what might be regarded as a standard specification of protection ; a standard which takes account of the many factors which concern architects, and in particular the question of cast.

Much has been said and written about shelters which are claimed to be capable of resisting the direct effects of a 500-lb. high-explosive bomb, but in my opinion there is not sufficient technical evidence available to justify the concentration of large numbers of people in any single shelter presumed to provide this degree of protection ; and, further, the thicknesses of concrete necessary to afford this degree of protection are so great as to be impracticable in terms of general building. The sense of security afforded by an apparently impregnable shelter is no doubt of considerable psychological value, but a direct hit from a bomb might cause casualties of disastrous proportions, followed ultimately by panic and a complete mistrust of other such shelters.

Even if the construction of such shelters for the whole population was considered a desirable policy, and was financially practicable, which it is not, they could only be provided by completely disorganising the whole of the building industry and its dependent organisations for many years.

It may be necessary, and desirable, in certain circumstances to provide a limited amount of such shelter accommodation in areas of a very vulnerable nature and where the risk of heavy attack is greatest. But it is the opinion of many who have studied this problem from all points of view that the most satisfactory results are likely to be achieved by providing within, or adjacent to, each and every building the best possible degree of protection for those who live or work in those buildings. Such a policy has advantages of great national importance : it distributes the population as widely as possible, it avoids the large concentrations of people which are so undesirable and makes it possible for every individual to reach his or her protected accommodation in the shortest possible time, an important consideration in view of the very short period of warning which might be expected.

Unfortunately, it does not appear possible to devise ways and means of guaranteeing the safety of every individual, but the evidence that we have secured from Spain and China does at least indicate that only a comparatively small proportion of casualties are caused by direct hits, and I have the impression that if the structural precautions which we have in mind could have been applied to all of the buildings in these countries, the number of casualties would have been reduced very considerably. Moreover, it does not necessarily follow that every building hit by a large bomb will immediately collapse : reports from Shanghai indicate that in at least two cases large buildings have been struck by 500-lb. high-explosive bombs with little material damage to the buildings and very few casualties among those occupying the buildings. I am afraid I cannot vouch for the quality of the bombs !

I have suggested that the structural precautions

which we have in mind are not likely seriously to interfere with the ideals of modern architectural design, but there are, of course, some buildings in which the effectiveness of structural precautions must be very limited unless considerable additional expense and inconvenience are incurred. In such cases the solution would appear to lie in the direction of evacuation, or the provision of protected accommodation outside the building ; but as a general rule it should be possible to provide accommodation within buildings which would give protection against splinters and blast pressure, and which would be safe in the event of the demolition of the upper part of the building. We can provide protection against poison gas and we can prevent the serious spread of fires which might be caused by incendiary bombs.

All these things you as architects may achieve and I suggest to you that even although the direct hit from a heavy high-explosive bomb must be regarded as a misfortune of war, protection of this limited nature is at least worth while !

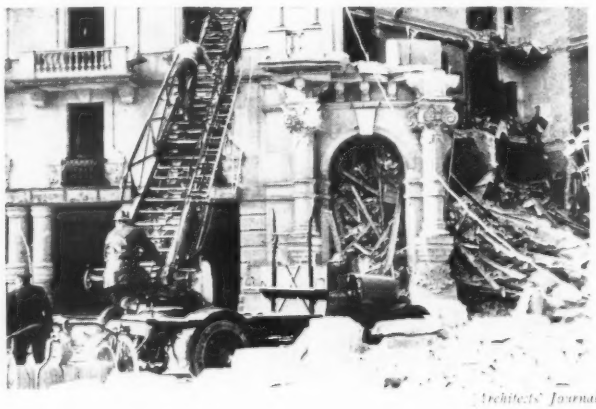
I have not the time at my disposal to explain those principles of planning and construction which are involved, but we shall endeavour to do so during the next two days and later, I hope, at short courses of instruction throughout the country.

In any case, it is hardly necessary for me to remind you, as architects, that every building is a law unto itself. It is this very fact which, to my mind, establishes the problem of structural precautions as an architectural and not an engineering or military problem : I am not sure whether the Home Office subscribes entirely to this view, but that is because it is not officially appreciated that the architect, and the architect alone, is able to effect the proper compromise between efficient planning, artistic quality, cost, convenience and even Air Raid Precautions. We, as architects, would not consent to deform our buildings in the anticipation of a war which might never come ; but with good design as the first objective, we may still incorporate structural precautions of a satisfactory nature which would not inconvenience the occupants of buildings during peace-time, but might be of tremendous value in time of war.

Mr. Bird, my colleague on the Structural Precautions Committee, will shortly review some aspects of structural precautions which have emerged from our study of the problem in connection with various types of buildings ; you will have your own particular problems, but they are none of them so difficult that you will not be able to do something of potential service to your clients and to your country.

I am only too conscious that my efforts to establish Air Raid Precautions as a problem for the architect are not as convincing as they might have been, but if any of you still doubt the possibility, or the need, or the wisdom of doing anything, I would remind you that many of us may owe our presence here to-night to a shallow hole in the ground or the fortuitous intervention of a brick wall.

I share with you the sincere hope that a war may never come to test the efficacy of the proposals I have placed before you to-night ; but if war should come their effectiveness will surely depend not upon the efforts of a few enthusiasts, but upon the extent to which the profession as a whole accepts this problem of Air Raid Precautions, and I commend it to your earnest consideration.



Collapse of a six-storey house in Barcelona, due to a 300-500 k. bomb falling on it. The debris from the upper part of the building has piled up at ground floor level

Architects' Journal

SOME GENERAL PRINCIPLES OF STRUCTURAL A.R.P.

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My part in the discussion of this unpleasant subject is to elaborate from a technical point of view several matters outlined by Mr. Scott, and to indicate a few of the ways in which structural A.R.P. can be applied in building practice.

In considering what is for architects a technical subject, it is first necessary to clear our minds of preconceived notions based on sensational newspaper articles or films. A first study must be of the known effects of bombs, eliminating guesswork as far as is possible in the present state of knowledge. For this we have at our disposal certain Government research data and also some recent practical information from Spain and China. In considering the latter, however, it is important to realise that the conditions in those countries, and therefore the observed effects of air bombardment in them, are not necessarily applicable to this country. Such information has to be scrutinised with some care and not used as a basis for rash generalisations.

The second part of our work must be to study the possible effects of various bombs on the numerous types of building that make up the modern town in Great Britain, and on the forms of structure in common use. Then we should discuss measures for the protection of the occupants of buildings, and for increasing the resistance of buildings themselves. It is on these lines that the Instructional Course, to be held during the next two days, will proceed. In the short time at my disposal I propose merely to make a few general statements, leaving their proofs and detail considerations to the other sessions of this conference.

The Town as a Whole

The modern English town, considered as a unit, is a poorer target than many continental towns, closely built up with blocks of flats. Our habit of spreading towns in low buildings with a large proportion of open space makes them a thin target. For example, in the post-war English suburb of twelve houses to the acre, the actual buildings only occupy one-sixth of the land. Dispersion is a first rule in passive air defence, not only in towns, but also with other aspects such as shelter design.

Bombs fall at an angle to the vertical. For instance, the angle of arrival of a bomb from an aircraft flying at 200 miles per hour at 12,000 feet will be 17.5 degrees from the vertical. At the same speed from 2,000 feet it will be 38.5 degrees. Hence in town centres, congested with tall buildings in narrow streets, the odds are in favour of the majority of bombs striking a building somewhere. Furthermore, such town centres have a dense population, particularly during the daytime. A single office building or factory may contain upwards of 1,000 persons. Therefore the tall city building represents a far more important problem than the small house ; it is also one with which architects are customarily more concerned. The householder of the outer suburbs can indeed well be left to provide his own protection on the lines already recommended by the Home Office and at best he is a relatively poor target. Nevertheless the provision in each new house of one room that will afford better shelter than the others, and that can be easily given additional protection, is a sensible precaution.

The high-explosive bomb depends for its effectiveness principally on its blast effect and to a less extent on demolition and fragmentation, or splintering. Such a bomb fitted with a delay action fuse can penetrate as many as eight floors of a structure of normal fire-resisting type, exploding in the basement. Fortunately extreme blast effect and extreme penetration cannot be obtained with the same bomb. The instantaneously fused bomb will detonate immediately on impact, even on water. Intermediate types are likely to penetrate some way into buildings before exploding, but not necessarily very far.

The Value of Structural A.R.P.

One often hears the statement that it is not worth while undertaking structural precautions because the effects of a direct hit cannot be guarded against. Such an argument is unsound. As Sir Samuel Hoare has told you, full protection of personnel in shelters can be obtained against three of the four effects of high-explosive bombs, namely, against blast, fragmentation and demolition. Experience in Barcelona has proved this course to be well worth while. In that city casualties per ton of bombs dropped have been much reduced since proper protective measures have been taken and the inhabitants have learned to use them. Further, in new buildings precautions can be taken to make the structure more resistant to all the effects of air attack without heavy extra expenditure or serious interference with peacetime use. For instance, while an abnormally thick

roof of reinforced concrete on a tall building is of doubtful value and may even prove dangerous, some thickening of upper floors will tend to make bombs burst before they have penetrated far into the building.

Another argument often heard is that one is safer in the open than in a building. A little thought will show that a superstructure above a basement shelter, of which the roof is reasonably strong, will tend to make the bomb burst early, which is surely better than letting it descend unhindered on to the roof of the shelter. Structural A.R.P. is not a matter of building dug-outs. In any case the populations of congested areas must inevitably be sheltered in buildings.

Some Points in Shelter Design

Shelters are best located below ground level where they are secure against blast and splinter effects. A basement shelter should have immediately over it a floor capable of taking the load of the superstructure if demolished. Calculation of loads shows that the resulting floors will not be excessively thick or expensive. Such loading is from 200 to 350 lbs. per square foot additional to normal live and dead loads. Precautions must also be taken regarding gas-proofing, alternative means of escape, flooding from burst sewers or water-mains, and ease of entry to the shelter from the building. In designing the latter the London County Council's regulations for theatre exits may be borne in mind. In these, a five feet wide staircase is required for every 250 persons, who can pass down it in a period of from two to three minutes. The air raid warning period for London is likely to be as short as seven minutes.

The Home Office have laid down as a general rule that not more than 50 persons should occupy a single shelter unit. This is an example of dispersion of target. In practice, however, this number may sometimes have to be exceeded.

Wherever possible shelter accommodation should be sealed against entry of gas. If it is unventilated there should be 75 square feet per person of absorbent surface in walls, roof and floors. Discomfort in unventilated rooms follows more from the rise in moisture content of the air than from increase of carbon dioxide. Unfortunately many densely populated buildings, such as large offices, cannot provide shelter on such a basis which at the same time gives reasonable protection against the effects of high explosive. In such cases it will probably be better to seek the latter and to rely on gas masks for security against gas. If a shelter is ventilated, the allowance of space should be 6 square feet of floor area per person, and the air intake should be at least 30 feet above ground level. Filters to ventilation plants are subject to testing and approval by the Home Office.

The Resistance of Structures

In considering structures alone it has become clear that the best type for resisting the effects of high explosive is the framed building of steel or reinforced concrete with light panel walls or large areas of glass. A bomb bursting within or just outside such a building will tend to blow out some of the panels, leaving the main structural members intact. The more an explosion is confined or "tamped," the greater damage is it likely to do. Almost all tall buildings erected during the last thirty years have been built as framed structures, at least in central London.

The older traditional type of structure having solid walls carrying floors may resist the blast effects of the more distant explosions because of the mass of its walls. But should a near explosion or direct hit blast in the base of a wall, the whole superstructure above the damaged area will be brought down, together with the floors it carries. The shock of such a partial collapse may well cause complete ruin of the whole building. It is this type which is almost universal in Barcelona, and there are, of course, a great many in the centres of English cities. The partially framed structure allowed under the 1894 London Building Act can be regarded as intermediate in resistance between the fully framed and solid wall types.

It is, I think, worth remembering that English allowances for loadings in structural design are about the highest in the world. Also we have very high standards of quality in the actual execution of building. It is my own opinion that English buildings would resist demolition far better than those of Spain, where standards both of structural design and execution are much lower. That is what I meant by saying at the beginning of this paper that conditions in foreign countries were not necessarily applicable to this.

I would suggest that the ideal building from an A.R.P. point of view is one of which the structure is a steel or reinforced concrete frame having light panel walls or large areas of glass and fully fire-resisting, provided its occupants can all be contained in a properly designed basement shelter, preferably of reinforced concrete.

Some Problems

Hitherto in this paper I have been considering principally counsels of perfection—some of the many points of structural A.R.P. which ought to be embodied in every new building erected in potential target areas. But application of protective measures will often be very difficult for one reason or another. Let us consider two cases.

There is the serious problem presented by working-class tenements. These are almost invariably sited in congested areas; they are built with the utmost economy of material and are rarely framed structures; and, unlike offices and factories, they have a night population and one particularly prone to terrors and rash action. The sites of tenements are usually excavated only to foundation requirements: I suggest that some increased excavation would provide a basement wholly or partly below ground level which would serve as a good shelter. Peace-time uses for the basement such as recreation rooms, communal laundries, perambulator and cycle stores could well be found. Tenement buildings are subject to extreme financial stringency; it is for the nation to say whether they are prepared to pay the small extra price per flat to give the tenants adequate shelter accommodation.

Another problem is the department store with its ground floor walls of plate glass. A measure which suggests itself is to provide a solid wall at the back of the window space instead of the customary light wooden panelling; the rolling steel shutter is quite useless against the intense blast and splinter effects of high-explosive bombs. The interior would be well protected and further, the owner would be in a better position to keep his business running even if the windows were broken—as they would be. This suggests that commercial concerns might well consider structural A.R.P. as a form of insurance against cessation of business; indeed many have already undertaken it for this reason.

The Structural Precautions Committee are convinced that the cost of embodying structural precautions when a building is in the design stage will be small. The provision of basement shelter accommodation will often be a matter of planning peace-time storage accommodation so that it can be readily converted, plus some thickening of the shelter walls and roof.

Existing Buildings

Many architects are being consulted on the preparation of A.R.P. schemes for existing buildings. At first sight some of the problems presented to them appear insoluble. But examination almost always reveals that something can be done and that it will be worth doing. Every building has at least places which afford better protection than others. The architect's problem will be to make the best he can of that partially protected space. For example, a tall building may have no basement or one that is vulnerable because it is open and surrounded by pavement lights and stallboard lights. But fire regulations will have required the staircases to be enclosed with solid walls and, especially if they are situated in the heart of the structure, they may provide quite good shelter accommodation. Indeed the vertical shelter built as a strong tower and incorporating a staircase is a good type which may be considered in the design of new buildings.

Defence Against Incendiary Bombs

Hitherto I have considered almost exclusively the high-explosive bomb. I have done so because I think it to be the form of attack most affecting structural A.R.P. But defence against incendiary bombs and poison gas is certainly not unimportant.

The incendiary bomb is relatively small in size, does not penetrate readily and its fire effect, though intense, is small in extent. The smallest type of incendiary bomb will not penetrate a roof of reinforced concrete five inches thick—a thickness commonly used in normal building. Several such superimposed floors will tend to confine the fire effect of larger bombs to upper storeys. Otherwise, dealing with the incendiary bomb is mainly a matter of fire-fighting—the earlier the better. Provision of suitable apparatus, on which the Home Office will advise, comes within the purview of the architect in preparing A.R.P. schemes for buildings.

Conclusion

It will be obvious that structural A.R.P. in England has many elements of uncertainty. It is to be hoped that we may never have that practical experience which would make it more exact. We have a few exact facts and a great many that are inexact on which to work. Beyond that, the architect must use his own judgment and knowledge of construction, planning and building use. Hardly any two buildings present identical problems. Perhaps the most difficult of these problems is assessment of relative risks. There are no golden rules universally applicable and no complete security, but I am convinced that properly applied structural A.R.P. can very greatly reduce the effects of air bombardment, even perhaps to the point of making it not worth while to the aggressor.

VOTE OF THANKS AND DISCUSSION

Mr. E. STANLEY HALL [*F.*] : It is with very great pleasure that I rise to propose a vote of thanks to the three speakers who have addressed us this evening. We are greatly honoured to-night by the presence of the Home Secretary, and it is impossible to think that the Conference could have had a better send-off than the address which he has given us. Sir Samuel Hoare has served his country in many high capacities and for a large number of years. Humbly over the past forty years I have watched his career from a distance since I was a young freshman at Oxford and he an exalted fourth-year man. Education gained by his work on the London County Council. Sometimes his thoughts were high in the clouds and at other times they were very much at sea. He has skated on ice both thick and sometimes thin. As President of the Lawn Tennis Association he has probably made an *ex cathedra* pronouncement on the value of shorts *versus* skirts. We all know his magnificent and heroic effort in piloting the India Act through the House of Commons, and his terrifically responsible period at the Foreign Office, which he has now left for a peaceful anchorage in the Home Office, where he has thrown himself with zest into prison reform and air raid precautions—those ill-matched pointers of twentieth century civilisation ! But for all his offices and for all his public service, I think this is the first time he has ever visited this building ; at any rate it is the first time that he has spoken here, so that he will be able to add yet one more feather to the caps which, like Mr. Winston Churchill, he has been collecting since his Harrow days.

We at the R.I.B.A. are only too anxious to bear our part in the necessary service of protection for our country, our people and our loved heritage of buildings. We do not want precautions so cumbrous and so expensive as to make the buildings impossible to live in at other times. We do not want them so perfect that we should almost miss it if we were not hit ! We do not want to be told to overload thin ceiling joints of antique buildings with several inches of sand, which we know will break the buildings down before the bomb comes. We are most anxious, however, really to find a solution for this difficult problem and to do everything that we can to help.

The distribution of the population is better than congregating them, and that, I think, is a very wise move ; as Mr. Bird said, dispersion is what we want. We are not allowed to have more than fifty people in a dug-out, but if there were a dug-out for fifty people we should, of course, have five hundred crowding in. We have, as the Home Secretary told us, to be extremely reasonable and sensible in this matter, and to make the best of our opportunities and do the best that we can.

The question of windows has not been touched on to any extent to-night, but I suppose that it is one of the great difficulties. I am concerned with a high building which presents an interesting problem because it is a hospital, and there we have overhanging reinforced concrete balconies, and I cannot help thinking that that is an extraordinary advantage in protecting the windows from the upward blast of explosions. My own view is that if you have a high building you should go half-way up it and then you will be above the gas and you will have greater protection against blast, while if there are a number of storeys above you there is a good chance that they will stop the incendiary and the lighter types of high explosive bomb.

I do not want to speak at greater length except to offer our very hearty thanks to Mr. Scott and Mr. Bird. We know that they are eminently able to give the instruction and information which must be disseminated through the towns and cities of this country, and for what we have received from them and for what we are about to receive from them we give them our very hearty thanks.

Mr. HERBERT RYLE [*A.*], M.V.O., O.B.E., F.S.I., Chief Surveyor to H.M. Office of Works and Vice-Chairman of the Structural Precautions Committee of the Air Raid Precautions Department : I appreciate very much the honour of being asked to second this vote of thanks. As a Civil Servant I am very diffident in seconding a vote of thanks to a Cabinet Minister, but I am sure that everyone here will agree that in giving this meeting a place in history he has done a great deal towards giving our Air Raid Precautions Conference a good send-off.

My principal object to-night is to explain to this meeting the extraordinarily valuable work which has been performed on the Structural Precautions Committee by Messrs. Scott and Bird as representing this Institute. I can say at once that they have been the moving spirits, the people who wanted to get things done and brought to an issue while the scientific experts continued to ponder on the various problems to which there was no real solution. These two gentlemen representing this Institute have rather forced the pace, and they have said, " Well, we have to settle on something and this is what we have settled on."

As Mr. Scott has said, they were introduced to a world which is about to go crazy, and they were faced with new and fantastic problems which had to be solved without any adequate data at all. There was plenty of data which told you how to design an air raid shelter or a bomb-proof shelter, but that is a simple matter because a bomb-proof shelter has only one job to

perform, and that is to protect you from bombs. It is a different matter when you have to design a building which has to be built at a reasonable cost and which has to be used and lived in, on the off chance, shall we say, that there may be a war !

Having deliberated on this problem, the Committee decided on two fundamental principles as regards the design of buildings. The first was that the building should be designed so that it would not suffer total demolition even if it were hit, and the second was that the building should be capable of affording shelter even if partly demolished for the occupants of the building. Neither of these requirements is too difficult to meet. It is important, however, that in the case of every building which is constructed from now onwards an endeavour should be made to meet these requirements, because it will then give effect to the principle which has been mentioned to-night, namely, that dispersion is the cheapest and most effective form of passive defence. Dispersion does not mean evacuation ; dispersion means keeping everyone as nearly as possible where he is within the building when the raid takes place and giving him reasonable lateral and overhead protection. If that is done, undoubtedly within a generation, at any rate, the possibility of casualties from air raids will have been very seriously diminished.

Sir Samuel Hoare assigned to me a task to-night which is not on my brief ; he said that I would tell you what the Office of Works were doing. I have not received any instructions from my Minister or from my Board, but I do not think there is any harm in saying what Sir Samuel told the House of Commons the other night, namely, that from now onwards the Office of Works in all the buildings they put up will make provision in some form or another for protection against air attack. Actually we have set up three standards. The first standard is for buildings where it is necessary to protect the vital services, such as telephone exchanges. People can go down to refuge accommodation but the telephone plant cannot, and therefore when we are considering the design of telephone exchanges we have to consider how best we can protect the mechanism of the telephone exchange, which is of vital interest, in war-time in particular. There we have set a standard which is perhaps somewhat high but which we hope will mean that the plant in the building will not suffer damage except from a direct hit by a fairly heavy high explosive bomb.

Our second standard of protection is the sort of normal standard in a vulnerable area, where we attempt to exclude incendiary bombs of the heaviest type that we know, and where we provide refuge accommodation for the inhabitants of the building. Our third standard relates to areas which may be considered less liable to attack or less vulnerable—remote places—and there our standard aims at excluding incendiary bombs but not necessarily giving strengthened refuge accommodation to the whole of the staff. When I say " refuge accommodation " I mean up to the standard of protection against high explosive bombs. We are adopting there the standard laid down by the Home Office for ordinary residences.

In all cases, of course, we are attempting to provide gas-proofing, and we are also, in the case of buildings which are staffed to any considerable extent, providing first aid posts, earmarking certain accommodation which we are fitting up with sinks and so on to be used as first aid accommodation, so that the staffs will know where to go in the event of casualties occurring.

I did not intend to make that speech at all, but I should like to say in conclusion that the Institute and the profession generally owe a great debt to Messrs. Scott and Bird for the enormous amount of work which they have put into this problem, for the imagination which they have brought to bear, and perhaps most of all for the restraint which they have also brought to bear, because there is no subject on which enthusiasts can wax so eloquent as air raid precautions, and it does require someone of the common sense of your representatives to bring these precautions down to a practical level. I have very much pleasure, therefore, in seconding this vote of thanks.

Mr. A. J. MacLEAN [*F.*] : I should like to ask Mr. Ryle one question. I think he said that the Office of Works were intending to protect in a special way buildings such as those occupied for telephone exchanges which are constructed in future. Is his Department taking any action to protect buildings which are at present in existence and which are used for such purposes ?

Mr. HERBERT RYLE : In so far as we can, yes. We cannot give the same measure of protection, of course, that we can give in the case of a specially designed building.

Mr. R. C. FISHER [*A.*] : One cannot speak on a subject such as that which we are discussing to-night without feeling a very heavy sense of responsibility both to our profession and to the general public. I should like to refer to the remarks which Mr. Bird made about the protection of the average tenement block in a working-class residential area. He said that the nation would have to decide whether it was worth while spending the considerable amount of money which it would be necessary to spend to give protection to the hundreds of thousands of people who live in tenement blocks of this kind. I want to suggest that although this type of tenement block houses a tremendous proportion of the working people of this country, an even greater proportion is probably housed in the ordinary residential working-class street, and generally in a very crowded area. What I feel is that if the people who live in streets of that kind are to be given any measure of protection which is not completely illusory, as much money will probably have to be spent on protecting them as will have to be spent on protecting those who live in these large tenement blocks ; because if you come to think of it, hardly any of the people who live in houses of this kind can spare a room to be set aside in which protective measures can be taken, and therefore it is obvious that special means will have to be adopted to provide protection in some way or other and to afford alternative

accommodation while it is being provided, if it is to be in basements at present in use. All this will cost at least as large a sum as in the case of tenement blocks.

What I want to suggest is this. If we look at the financial provisions which have so far been made, we must come to the conclusion that the 2d. rate which is contemplated, and the maximum 85 per cent. grant from the centre which is contemplated in addition, is not going to be anything like enough in practice in a big town to provide even moderate protection, or indeed almost any measure of protection, to the vast mass of the population. I do think, therefore, that as architects we ought to consider very seriously this whole problem of shelters, and I am very glad that we are taking it up and considering it seriously.

Wing-Commander T. R. CAVE-BROWNE-CAVE, C.B.E., R.A.F. (ret.), M.I.Mech.E. : I should like as an extension to the admirable summary which Mr. Scott gave in opening these proceedings to suggest that it will be the main object of the enemy to interfere with the normal life and normal work of the people as much as possible. To defeat this aim we must arrange that the provision which we make for protection should be such as to involve the minimum disturbance of that work and life. I think, therefore, that the conclusion which the Department has reached in recommending that protection must be provided within buildings and as near as possible to the positions of the work and life of the people is unquestionably correct.

Mr. Bird, in referring to shelter rooms, emphasised the importance of providing them with a roof strong enough to hold the building if it collapsed above it. I think it is very important also to realise that the exits from these shelters must be so placed that they are very unlikely to be blocked when the building above collapses, and the exits should have doors which open inwards, so that the occupants have, at any rate, a sporting chance of being able to get the doors open if wreckage is lying upon them.

There is one purely general point to which I should like to refer in conclusion. I submit that a very large proportion of the population will at the time of an air raid be in small houses, and therefore it is important to give small houses that degree of protection which is reasonable. I think the main risk so far as small houses are concerned may be summarised as "incendiary bombs and bits"—bits of anti-aircraft shell and bits from other explosions—and to a certain extent machine-gun fire. The 5-inch concrete roof is a complete answer there. If you provide small houses with a 5-inch concrete roof, the people inside those houses will be wiser to stay comfortably inside them and not go outside to seek protection elsewhere. If we are going to be exposed to a succession of raids, houses with this simple degree of protection will be an enormously important factor in preventing a large proportion of the public from being worn out with worry and distress every time an air raid occurs. I do submit that architects can greatly increase the protection, and even more, the peace of mind of the public by developing the ordinary small house with the flat concrete roof instead of the pitched roof. In my opinion, that is the quickest, the easiest and perhaps the most effective change which the architect can introduce into new building construction.

Mr. S. N. COOKE [*F.*] : North light factories are common in a large part of our industrial area, and I should like to ask what is the best protection in their case. Assuming that there is ground round those factories, is their best protection simply to dig trenches round them, or should we try to arrange for concrete shelters? I have had this question put to me in Birmingham by important clients of mine, and, quite frankly, I have not been able to give the answer. I feel that where there are thousands of men working in very important industrial undertakings, particularly on armaments, which would very likely be the object of air raids, the question of the best protection is a very important one. Should the workers be dispersed to their homes, or should we try to provide them with some protection on the spot?

Mr. GILBERT H. JENKINS [*F.*] : In supporting the vote of thanks, I should like to express the hope that Mr. Scott and Mr. Bird will carry their information with regard to the protection of such buildings as flats a little further.

As they advise that in large business premises such as stores, the staircase shall be protected and act as a shelter within each building when it or the vicinity is bombed, I conclude this would apply to blocks of flats also. They also suggest that framed construction for buildings is to be preferred, and that the walls should be thin panels so that when the explosion takes place, the walls will be burst out. Do I understand that the staircases should be put in the centre of the buildings and that the walls of those staircases should be considerably reinforced so that they will stand the shock and blast of the explosion except when there is a direct hit. Further, as many flats are now being designed with internal kitchens and bathrooms, would they not advise that strong walls should be put round those kitchens and bathrooms so that in the case of intensive air raids the people could live on the staircase and be provided in the kitchens and bathrooms with sanitary conveniences and cooking facilities if the outside walls disappear owing to explosions.

This would seem a logical alternative to the idea of making the structure of the floor over the basement so strong that it will withstand the collapse of the building upon it, and in view of gas attacks (from which the upper floors of a building will be more immune) it would seem to be the better alternative as, under such planning, life could be more easily carried on in a partially wrecked building. Air ducts could be coupled, and one could act as an intake during wartime.

It should be remembered, however, that the risk of explosion in any particular building in London is remote. As the area affected by an explosive bomb is stated as fifty yards square, this in relation to the County of London works out at 1 in 25 millions.

I should like to refer to the question of the glazing of buildings. Those of us who lived in London during the war will remember the bomb which dropped outside Charing Cross Hospital and killed several people. All the windows in that street were shattered except those of the British Medical Association building, which had lead-glazed windows, and none of those windows were broken by the explosion or by the blast. I wonder whether it is advisable, therefore, that we should go in for lead-glazing for all our windows, so as to limit that risk in the case of an air raid.

Mr. RAYMOND WALKER [*L.*] suggested that the building societies should organise finance for air raid precautions work.

Councillor J. CLARK, Mayor of Camberwell : A large number of people in London who have been re-housed under

the Housing Acts are living in tenement dwellings of the type to which reference has been made, and which are apparently extremely vulnerable because of their solid walls and lack of steel frames. All those buildings have been erected with the assistance of subsidies from the Government. In the event of any local authority embarking on air raid precautions in connection with those buildings or with any future buildings, can we be told what assistance such local authorities are likely to obtain from the Government beyond the ordinary housing subsidy?

Mr. F. T. BUSH [*A.*] : I should like to ask for your sympathy ; I have been an Associate of this Institute for thirty years, but this is the first time I have spoken here. I want to put to you the humanitarian point of view on this subject, which seems to have been entirely neglected up to now. I should like to refer to a remark which Mr. Scott made when he said that this was diametrically opposed to his ideals. It does arouse in me, as I think he said it did in him, moral indignation that we should at this time be spending all this effort and energy and money on what I believe to be futility. I think that we are at a cross-roads. The question is whether we shall take a decent course or not. We are architects and we have ideals ; let us be frank and sincere about it, and, I suggest, let us have nothing to do with all this nonsense. The whole business is nonsense. When I hear some of the remarks which have been made to-night I do not think that those who have made them can have had experience of bombs. In view of the colossal size of this problem, quite frankly I do not believe that there is much that can be done. I was concerned recently with a building when the apportionment of cost for air raid precautions, which was £10,000, was between 8 and 10 per cent. of the total cost, but I do not believe that that is going to be any more protection than an umbrella under Vesuvius.

There is another point to which I should like to refer, and that is the psychological effect of all this upon our friends and upon our potential enemies on the other side of the water. Do not the air raid precautions in those countries make us a little more afraid, and do not the air raid precautions here make them afraid? Mr. Bird referred to a "better 'ole." I believe that there is a "better 'ole." I think quite frankly that we should, as an Institute standing here for art, which is international, hold out our hands in friendship to our brothers across the seas, and I wish to make a practical proposal. I know that I shall not be popular, but I cannot help that. The proposal which I make is that this Conference defer any action in connection with air raid precautions until September, and that we should at once invite an international conference of architects to be held, and call in the German architects and the Italian architects and others, and let us discuss together this question of air raid precautions. How can you sandbag St. Paul's Cathedral? How can you protect St. Peter's at Rome? I suggest it is impossible, and there is a further factor : what about all the services in this complex community? What about the sewers and the gas and the water and the electricity? What are we going to do about all that?

I listened with great interest the other night to the Minister for the Co-ordination of Defence, Sir Thomas Inskip, who suggested to us that he was employing most eminent scientists and that they had something up their sleeve—something devilish up their sleeve ; there is no question about that ; something to make other people fearful. That gentleman is president of a Christian union to which my children belong. I know that that is irrelevant, but I call that hypocrisy ; I cannot help it I speak here as an ordinary Christian man. I took part in the last war, and I was in the Infantry. I am as keen as anyone else on doing anything I can for my country, but I can never kill anyone else again ; I cannot do it. Unfortunately, I am in a different position to Mr. Ryle, because Sir Samuel Hoare is my chief ; I am one of those, I hope not too despised, official architects. I am prepared to do everything I can for Sir Samuel and for my country—or for anybody else's country. I think that that is the whole point. Sir John Simon told us the other night that he quite believed that we were prepared to sacrifice our time and our money for the might and majesty and power of this great country. There are higher things than that. I am interested in my country, but I am much more interested in justice and righteousness and the welfare of mankind.

The PRESIDENT : I am afraid that I must remind the speaker of the three-minute rule, because we are all very anxious to hear the replies which are to follow, and the hour is already late. This, however, is only the opening meeting of the Conference, and there will be plenty of opportunity for questions later on.

Mr. BUSH : I hope, Sir, that you will allow me to conclude ; this is the first time that I have ever spoken at a meeting of this Institute. I would earnestly beg my colleagues, as architects, to realise what they are here for. We shall soon pass on ; it is the spirit of man that lives. I hope that you will not forget my small effort, because I think that you will do more good in the ways that I suggest than you will by tons of cold concrete.

Mr. A. D. R. CARÖE [*A.*] : We have been told that air raid precautions work belongs essentially to peace-time, because in time of war the labour and the materials will be unobtainable. I should like to mention one question which is closely bound up with the matter, namely what can and what architects ought to do in the event of the outbreak of war. If this country is involved in war, the whole national life will instantly have to be transferred from a peace-time to a war-time footing, and our normal professional practice will vanish in a night and in its place there will be national needs. We are told on the best authority that under modern conditions of warfare all the necessary reorganisation will have to take place not in a year, or a month, but in a week, a day, or an hour. What in these circumstances ought an architect to do?

Every thinking man appreciates the immensity of the problem which the Government has undertaken, and is undertaking in re-organising and preparing the necessary organisation, but is the Government certain that it is already in touch with all the skilled technicians who will be required if and when this emergency arises? If not, I should like to point out that there are hundreds of architects available who, with only a short course of special training, could be made completely efficient for such jobs as planning arrangements for factories, warehouses and refuge camps, working out details on the drawing board, surveying sites or supervising construction in connection with countless emergency works, from trenches to hospitals. It seems to me that the profession needs

a lead, and that if the Government will give it, it will be surprised not only at the enthusiasm of the response from architects, but also at its efficiency.

As a last point, I should like to mention that since architects belong to a profession, their voluntary organisation will not involve some at least of the difficulties which are so commonly met with by the Ministry of Labour.

Mr. W. H. ANSELL [*F.*] : I should like as an old "shell-back," who has, unfortunately, in his own person experienced the disturbing effects of cloud gas, of mustard gas in shells, and of high explosive, to say how inadequate I find moral indignation as a defence against high explosive. We are, unfortunately, not the disposers of these things ; if we were, there would be no need for protection against any of them. But we stand here to be shot at, and I fear that the probabilities of our being shot at are greater to-day than they have been for many years, and therefore I consider that it is incumbent upon us to do everything possible to protect ourselves and to minimise the effects of any attack which may come.

I still believe that attack is the finest defence of all, and, while we are talking about air raid protection, that the defence of the first ring of fighters and of anti-aircraft artillery is the best of all defences. I think it is impossible that London should ever be subject to such attacks as Canton has had in the last few days. Nevertheless, there may be isolated aeroplanes which get through, and it is undoubtedly necessary for us to consider what would be the effects of their coming over and attacking us.

Dispersal is one of the finest means of protection. The man who lives in a little house at eight or twelve to the acre in the suburbs of London is in very little danger. If all such people will take the trouble to dig a small trench in their own gardens, I believe they will give themselves a measure of protection which we in the last war found to be invaluable. I lived for very many months in a hole in the ground, and I have lived in the ramparts at Ypres, and I know the feeling of security that is given by the knowledge that one is below the surface of the ground. For the ordinary householder there can be no better protection than that.

As regards the thicknesses of floors, we found the burster layer in the old days very valuable indeed, and in building reinforced concrete machine-gun emplacements and shelters in and near Ypres, we generally managed to get one or two burster layers above the actual structure. If new buildings in London could have a gradually increasing thickness of floor strength, with the very top floors comparatively light, but with the floors gradually increasing in thickness in the lower storeys, even the delay action bomb would meet with ever-increasing resistance to its penetration and its bursting. If only it were possible to burst the bomb sufficiently high above the level of the ground there would be in that a measure of protection, and if the final protection in the basement were sufficiently strong to hold up whatever of the upper part of the building should fall upon it, then again there would be a feeling of security and protection given.

I still think, however, that dispersion is the best remedy of all —the old idea of spreading out and not bunching together, which we found most valuable in any kind of attack. One man might die, but his fellow a few yards away would live. If only we can prevent our population from bunching together in too great numbers in any one place, we shall at any rate have accomplished something towards protection.

The PRESIDENT then put the vote of thanks to the meeting. It was carried with acclamation.

The Rt. Hon. Sir SAMUEL HOARE : I will reply to the more political questions which have been raised, but first I should like to thank the proposer and seconder for the very kind remarks which they have made about me. First of all Mr. Stanley Hall gave a very friendly and flattering description of my rather mixed and lurid political career, and I am very much obliged to him for what he said about me. Like Lord Nelson, he turned a blind eye to what he did not wish to see. Then there was the distinguished Civil Servant who seconded the vote of thanks, Mr. Herbert Ryle, and I would say to him as one who has held office for a great many years how much we Ministers owe to the great Service of which he is a distinguished representative. You will remember that it was said of the Civil Service that they are the people who tell Ministers what to do, and it is the duty of Ministers not to do it. In this rare instance, however, great minds work together, and I do not think there is any disagreement between his and mine.

Now let me come from those personal observations to one or two of the wider issues which have been raised in the discussion. Perhaps the biggest of them is the great issue of Pacifism against defence. I do not impugn anyone's motives and I do not underrate the sincerity of my fellow citizens who take a different view from my own ; but I do feel that of all the forms of defence, air raid precautions are the least provocative. It may be said that the raising of armies and of navies and of air forces stimulates the raising of armies and navies and air forces in other countries. That cannot be said of air raid precautions ; it cannot be alleged that the fact that we take the kind of precautions which we have been discussing to-day in our offices and in our private houses can in any way be regarded as a stimulus to militarism or as an incentive to war. So far as the bigger issue is concerned, I am just as great a Pacifist as anyone in this room. I should be delighted to see the abolition of air forces over the whole world. None the less, so long as we have the world in its present state, so long as we are threatened with the kind of dangers to which no sensible man can be blind, I am not prepared to see this country be the only great country in the world to remain defenceless ; and on that account, with all due deference to what was said with such sincerity and such fervour by Mr. Bush, I still say that it is our elementary duty, not only as public men but as ordinary citizens, to do what we can to fill what is a most dangerous gap in our national defences, and, by filling that gap, to make it much less likely that any foolish or irresponsible aggressor in the

future will ever be tempted into trying what is called nowadays "a knock-out blow"—that is to say, the kind of attack which might knock this country out before we could mobilise our great potential reserves. I hope, therefore, with all due deference to the speech made just now, that you will not be drawn aside from your elementary duty as citizens of a great country, and that you will help us in this great effort to fill what is at present a dangerous gap in our national defences.

There was another political question raised in the discussion, the question of finance. It was suggested that the money that we are spending upon air raid precautions is inadequate and that we ought to spend much more. I do not want to prejudge what may happen at some indefinite time in the future, but I do say that as things are at present, we have to keep a sense of proportion ; we have to remember that however important passive defence may be it is only one part of air defence. Mr. Ansell spoke very truly when he said that our first line of defence was the Air Force and our second line of defence the anti-aircraft artillery. If we lose a sense of proportion and concentrate too much upon expenditure upon passive defence, it may well be that we shall not be able to devote a sufficient national effort to these two first lines of air defence, namely, the Air Force and the anti-aircraft gun.

So far as the relations between the Exchequer and the local authorities are concerned in the matter of defence, I am inclined to think that upon the whole we have reached a fairly satisfactory compromise. The Exchequer is finding by far the greater part of the money ; over the whole field it is finding something like 90 per cent. ; and we did feel, and I believe rightly, that in a matter of this kind in which the local authorities must take a prominent part, it is absolutely essential that they should have some responsibility for the expenditure and that, if they have little or no responsibility for it, it will be much more difficult to maintain—I do not say with all authorities, but I do say with some—the kind of standard of economy that every citizen of this country expects. I am inclined to think that the preparations that we are making and the expenditure that we are providing for air raid precautions, so far from being useless, is going to afford a very effective protection upon the lines that we have discussed this evening. Further, I believe that if the individual citizen will take his part and help his local council and help the Government, and, most of all, help himself, we can prevent the kind of panic happening in an air raid which might bring the national life to a standstill, and I believe that we can prevent appalling catastrophes in regard to loss of life being inflicted upon the country such as would certainly happen if men and women were not trained before the emergency, and if we did not take the kind of precautions both in regard to training and in regard to structural protection which we have been discussing this evening.

I have dealt with those two political issues, and I leave the points connected with structural problems to the two excellent speakers who are to follow me.

Mr. THOMAS E. SCOTT [*F.*] : I am afraid that if I were to attempt to deal adequately with the technical points which have been raised in the discussion we should still be here at 10 o'clock to-morrow morning, when we are due to commence our course of lectures. I should like to remind all of you that during the next two days we hope to deal adequately with these points and with many others. There are a few, however, to which I should like to refer now.

Mr. Hall said that we have not made a reference to the window problem. I think it was Mr. Ryle who, in the course of one of our discussions, expressed the view that the best thing to do with windows was to go round with a hammer and smash them just before an air raid started, and I think that there is a good deal in that. It does not appear possible to devise a window which will withstand even the distant effects of blast pressure. We are still pursuing this problem, however, and sooner or later we may be able to make recommendations which will enable you to design and construct windows which will withstand blast pressure from a reasonable distance ; but that is all. I am afraid that some of the more modern-minded members of the Institute will learn with alarm that the leaded-light window does withstand blast pressure better than others, but I hope that that scientific fact—it is more or less a fact, I believe—will not bring about another revival !

Mr. Hall contended that it might be safer to be in the middle storey of a building than lower down. That may be right or it may be wrong ; as we have tried to suggest to you, every building is a law unto itself, and it is quite impossible to lay down as a golden rule of design that the shelter accommodation should be in the middle of a building. Each building presents its own problems. In some cases it is true that it may be best to provide some sort of protected accommodation some floors up.

Mr. Hall also referred to the use of projecting balconies. These balconies may, and probably will, in many cases afford protection against fragments from bombs bursting at street level, but the balconies will not protect the glass in the windows. If the glass is damaged, as it probably would be, it will be damaged not by splinters but by blast pressure, and even a sheet of steel half-inch thick rigidly fixed over the outside of a window opening will not protect the glass against blast pressure ; the glass will still break.

Mr. Ryle made some very kindly references, for which I thank him, and I thank him also for not having introduced any more technical points to be dealt with.

Wing-Commander Cave-Browne-Cave referred to a problem which I know he has had in mind for a long time, and that is the desirability in his view of the flat concrete roof on all buildings. It is true that a 4-inch solid reinforced concrete roof will keep out the small incendiary bomb and the other smaller incidentals of aerial warfare, but I should not like, as a member of the Structural Precautions Committee, to recommend that the flat concrete roof should be standardised throughout the country; I am still old-fashioned enough to like tiles and slates in suitable positions. I think, however, that what he suggests can be applied in part to small houses; I see no reason why we should not continue to use slates and tiles where appropriate, and possibly construct a 6-inch reinforced concrete floor over one room in each small house, so as to afford protection for individuals against the smaller projectiles of aerial warfare. That would not cost very much, and it would still leave architects free to practise or perpetrate their methods of design according to their taste.

Reference has been made to the problem presented by the north light factory building. I need hardly waste any time in trying to convince you that we have no means at our disposal of keeping bombs out of glass! In the course of the next two days, however, we shall be making some reference to the sort of protection which may have to be devised in buildings which are wholly or in part single-storey buildings and are covered in the main with a glass roof.

Mr. Jenkins referred to the problem of the staircase shelter in blocks of flats and similar buildings. That again is a form of protection which we have considered and which we recommend as very desirable in such buildings, because it would not interfere with the logical design, planning and construction of the rest of the building but still would, within the staircase tower, provide very suitable accommodation; and if the kitchen or some similar apartment could be incorporated in this solid internal tower, it would provide an excellent place of shelter for the occupants of a block of flats, and the external walls of the block of flats could still be largely constructed in glass, or whatever other material the architect sees fit to use.

There are other minor points of a technical nature to which I cannot refer to-night, but I should like to remind one or two of you who still appear to hover on the brink of this problem that, as I suggested in my paper, horror is not an excuse for ignoring the technical aspects of this problem. We none of us want war, and on the Structural Precautions Committee we have deliberately avoided the consideration of any structural precautions which might have the effect of debasing or deforming architecture; but we still think that without upsetting any of your ideals of planning and design you may incorporate certain structural principles which, if war should come, will give people at least a better chance of safety. I submit that such an aim, if taken up by this profession as a whole, is as humanitarian as the aim of any Pacifist.

I do ask you on behalf of the Structural Precautions Committee to accept this problem in its technical aspects, and in thanking those who moved, seconded and supported this vote of thanks, I should like to say that the reception which has been accorded to Mr. Bird and myself to-night must be very gratifying to those who have worked for the last three years on the Structural Precautions Committee.

Mr. ERIC L. BIRD [*A.*]: There is very little left for me to say which cannot be said to-morrow, but perhaps I may be allowed to refer to one or two points. I think that I did say in the course of my paper that I was only proposing to make a few assertions about isolated problems. Mr. Fisher has referred to the question of the old terrace house in the inner suburbs of our cities. I agree that that is a very serious problem because so many of these houses are sub-divided into flats or offices and sub-let to individuals. Often there is a sort of hierarchy of three or four owners or lessees, eventually coming down to the unfortunate individual who has the single unit room. The question of how to protect the people in such a building is a very serious one, but I do not think that it is necessarily one for us to solve. If we are asked by the Government to make some pronouncement on this question we can do so if we study it; but this question of leasehold properties is mainly, I feel, a political problem. We can only deal with the problems which are presented to us by our clients, and I do not think we ought at present, at any rate, to concern ourselves with the larger problems of the protection of the population as a whole, because they are matters on which to begin with the Government must decide the fundamental policy.

I felt very great sympathy with Mr. Bush when he told us he thought we ought to do nothing about this matter, because he stated very precisely my own point of view when I started to study this problem three years ago. At that time I felt exactly as he does now, that we could do nothing, and that A.R.P. was against the natural development and the advancement of architecture; indeed against everything that we stood for. I have come little by little, however, to see this problem in the light in which the Government sees it. After all, we are a democracy and the Government are our elected representatives. It is for them to decide policy on our behalf. The Structural Precautions Committee have had a great deal of information presented to them, and they do see this to be a very real problem and, moreover, a problem which we as architects are particularly fitted to tackle on behalf of the nation.

I should like to thank Mr. Stanley Hall and Mr. Ryle for moving and seconding this vote of thanks.

THE INSTRUCTIONAL COURSE

FIRST SESSION

TUESDAY, 14 JUNE 1938, AT 10 a.m.

METHODS AND EFFECTS OF ATTACK AND PRECAUTIONS IN GENERAL TERMS

Mr. E. L. BIRD: We are not concerned here with the official A.R.P. organisation of local authorities nor of the Government but entirely with the technical aspects of structural precautions. They are quite new and untried and as more knowledge and more technical data become available, practice will to some extent change, and we must be prepared for that. What Mr. Scott and I say now may not apply in six months' or a year's time but I do not think that it will vary much, because we in this country have reached the stage when we do know a good deal about it.

Complete protection is impossible and the first principle to emphasise is the principle of dispersion. The modern bombing aircraft has a capacity of about 3,000 lbs., a range of upwards of 2,000 miles and a speed of up to 300 m.p.h. That means, in effect, that no part of the British Isles can be considered to be immune so far as distance is concerned, although obviously some targets are more likely to be sought than others. Attack from the air may include the use of high-explosive bombs, incendiary bombs, gas bombs, gas spray and machine gunning, and there is also the danger from anti-aircraft fragments.

High-Explosive Bombs

The ordinary high-explosive bomb weighs up to 500 lbs. and in exceptional cases as much as 2,000 lbs. The extent to which a high-explosive bomb will penetrate into a structure depends on the purpose for which it is constructed and fused. A bomb with a percussion fuse will burst on striking any hard surface; with a delay action fuse it will, if suitably constructed, penetrate some distance into resisting materials before exploding. The heavy armour-piercing or semi-armour-piercing bomb will penetrate into about 6 ft. of concrete before exploding and will require another 10 ft. of reinforced concrete to resist the downward blast effect.

Consideration must also be given to the blow of impact from a heavy bomb. On an unyielding target such as a very thick concrete slab, the energy of impact of a 500-lb. bomb dropped from 10,000 ft. is of the order of 5,000,000 ft. lb. Those who are interested in the theory of statics will realise that the very slightest amount of give in a surface will make a considerable difference to the effect, both in regard to impact as well as blast and a theoretically unyielding surface would go very easily. Fortunately, no building has a theoretically unyielding surface.

It is necessary to distinguish between the armour-piercing and the semi-armour-piercing bomb. The former is specially constructed for use against naval armour and is not really our concern; it is the semi-armour-piercing bomb, which is intended to penetrate buildings, which concerns us.

Damage may be caused by the blast due to the air-pressure produced by the explosion. This pressure is of considerable magnitude but of very short duration and is followed by a suction wave which in some cases does more damage than the original impulse. I referred last night to the fact that the tamping of an explosion adds greatly to its power and I should like to give one instance of that. If a bomb bursts in the middle of a street, the effect of that bomb on a building opposite will be of considerable magnitude if there is another building on the other side of the street, because then the explosion will be confined and tamped, whereas if there is an open space on the other side of the street the blast effect tends to dissipate.

Blast effect is different from wind pressure; it is not a static load like wind pressure, because of the suction-wave effect. The Building Research Station is at the moment, at the request of the Home Office, trying to translate these blast pressures into equivalent static loadings comparable with wind pressures, but it is a very complicated and abstruse mathematical subject and no results have so far been published, though they may be before long. With a 500-lb. bomb, for instance, the force of the blast begins and ceases within eight ten-thousandth parts of a second.

There is a general rule—it is very general and must not be taken as final—that walls which will normally resist the maximum splinter effect of a particular bomb will, provided they are adequately braced, resist its blast effect.

We have had a recent example from Barcelona of the effect of a bomb estimated to be of 1,000 kg., the heaviest type there is, which fell in the centre of a street 50 yards wide—a very wide street. The buildings had stone fronts of rubble masonry with heavy cornices and stone balconies, but otherwise are described by an engineer who made the report as being of a rather flimsy character. The maximum blast effect was felt over a radius of 150 ft. and the buildings on both sides of the street in the immediate vicinity were entirely demolished. It formed a crater some 30 ft. in diameter. We can regard that as being something like the maximum blast effect of a single bomb.

On the question of fragmentation or splintering we have some moderately exact data, which relate to the effect of a 500-lb. bomb at 50 ft. and show the thickness

of material required to resist the maximum splinter effect.

Mild steel	1½ ins.
Stock bricks in cement	13½-in. solid 15½-in. cavity
Unreinforced concrete	15 ins.
Ordinary reinforced concrete	12 ins.
Specially reinforced concrete	10 ins.
Sand or earth revetments	2 ft. 6 ins.
Shingle between wooden sheathing or corrugated iron	2 ft.

It will be noticed that the 11-in. cavity wall does not appear in that list at all. The specially reinforced concrete is the type in which the reinforcement is designed to resist the extra high shear stresses caused by the " punching " effect of the splinters.

Incendiary Bombs

Incendiary bombs vary from 2 lbs. to 60 lbs. or over in weight. The smaller sizes are likely to be used, in order to achieve the most widespread effects in relation to the number of aircraft employed. A machine with a capacity of 3,000 lbs. can carry a very large number of 2-lb. bombs. Incendiary bombs may contain one of a number of highly inflammable materials which burn at a very high temperature for several minutes and cannot be readily extinguished.

The important thing, of course, is to localise the effect of these bombs and to prevent the spread of the fires which they cause. There is a type of incendiary bomb which has a mild explosive effect as well, which throws the inflammable contents about. The penetrative power of an incendiary bomb is usually less than that of a high explosive bomb of equal weight.

Gas

A.R.P. Handbook No. 2 contains a fairly full description of poison gases and it is not necessary to do more than say that there are roughly two types, the persistent and the non-persistent, the persistent gas being mainly " mustard," which is a liquid which vaporises from time to time and may have effects up to three days after the bursting of the bomb.

Other Dangers

Anti-aircraft fragments are quite important, because the modern anti-aircraft gun has a ceiling of about 30,000 ft. and pieces of metal coming from that height arrive at a very considerable velocity. Machine-gun bullets have also to be considered.

Effects and Precautions

The semi-armour-piercing bomb can be counted on to go right through a London Building Act 80-ft. building from top to bottom. The terminal velocity of a 1,000-lb. bomb from 12,000 ft. is 850 ft. per second. I gave yesterday some details of the angles of arrival. A point to realise is that with a very tall isolated building it is quite possible for a bomb to come in at one side of a building and go out at the other without hitting the roof at all. Windows and walls have, therefore, to be considered as vulnerable to direct hit and the wall is to some extent as important as the roof: it is obviously a matter of relative area and a relative area which cannot be established exactly. A point to realise from the outset is that the enormously thick roof, beloved of novelists writing of the future, is not very practical, because the immense force of the blow of the falling bomb is so likely to cripple the stanchions. It is possible, however, to slow the bomb up by a series of special superimposed floors, which will tend to make it burst early.

One fact which has been observed in Spain is that demolished rubble masonry buildings have a definite area of spread. One report said that the distance from the original front of the building to the edge of the debris was 18 to 20 ft. in a very large number of cases. It must obviously depend to some extent on the height of the building, and the buildings in the case in question were of four or five floors. This is a matter for consideration when dealing with possible escapes from refuges. There were, of course, pieces of debris considerably further away than 20 ft., which is the figure for the main edge of the mass and relates not to the radius but to the distance along the face of a street from the demolished building.

The meeting was then thrown open for questions.

Question : Is it possible to use shingle in sandbags?

Answer : I think so, yes. For information on sandbagging and shingle you will find the *Manual of Field Engineering*, Vol. 2, is exceedingly useful. A new edition has just been published.

Question : Is there any information about the scantling of supports in basements? The sample room at Charing Cross station had one 4 x 3 post to carry 100 sq. ft. area.

Answer : Information on this is in course of preparation. (See Appendix on page 832.)

A Member : The framed construction that you recommend is equally suitable for resistance against cyclones and tornadoes and earthquakes. Before the war I put up a reinforced concrete building in Canada, at Regina. The entire city was wrecked by a cyclone, and this reinforced concrete-framed building stood right in its path, but all that happened was that a few of the panels were blown out; the building itself was practically undamaged.

Answer : That is very interesting, and raises another point. The question has been asked whether if a bomb bursts in the ground near a building earth pressures will be set up causing anything comparable to earthquake effects. We have no evidence that that is a matter of any moment, although obviously there must be a very considerable impulse wave through the ground, and it seems possible that, for example, a basement brick retaining wall might very well be pushed in.

Question : Is there very much difference between the effect of the present type of bomb and that of the bombs which were used in the War?

Mr. SCOTT: A representative of Ordnance Research said he did not think it necessary to expect that any more powerful explosives would be devised than those used in the last war; he thought we had reached more or less the practicable limit.

Question : There must be a great deal of evidence from

France, for instance from the bombing of Rheims cathedral and the buildings in the square there, many of which are 60 feet high. The bombs went right through them, but did not destroy them ; they made enormous cavities in the cellars, but the buildings did not collapse, although they were poorly constructed.

Answer : They may have been delay action. I saw a farmhouse in France hit by a naval type delay-action shell from a long-range gun which went right through the building and burst in the cellar, and it merely blew in the floor of the cellar and cracked the foundations of the house.

Question : Have you any information as to the advantages of different types of reinforced concrete floors ? I have in mind comparison between the old-fashioned type of construction with filler joists, the rod reinforcement, and hollow tile slabs.

A Member : Rolled steel reinforcement was found in France to be absolutely useless against shock. I have in mind a case where there was a burster course consisting of an 18-inch concrete slab reinforced with steel joists at 2-ft. centres, and underneath the dugout roof with 2 ft. 6 in. to 3 ft. of concrete. That was struck by an 8-in. or 9-in. shell and the whole of the upper part of the bursting course was shattered, the concrete being split along the line of the joist, showing that a steel joist reinforcement in concrete is useless against shock and simply gives a line for the shearing of the concrete.

Answer : I agree. The engineers who have been studying this subject say that it is definitely desirable to have cross reinforcement and run the bars both ways in the slab, and probably on both faces as well.

Question : Are we contemplating the erection of framed buildings with walls of reinforced concrete 12 in. thick, and, if so, are they considered blast-proof and splinter-proof ?

Answer : No, we are not contemplating that, and it is no use recommending people to do something which they will not do. Buildings to-day will have fairly large windows, and it does not matter much if the breast walls underneath such windows will not stand the maximum effect of splinters from a 500 lb. bomb at 50 ft.

Question : May a bomb be deflected in its course through a building ?

Answer : Yes. A light case bomb which strikes a main structural member is very likely to be deflected, and in some cases to be broken up, so that the blast effect is reduced.

Question : Do you find serious casualties from shock inside a shelter which is struck but not demolished, if the air space is limited ?

Answer : I do not know of any cases, but the possibility of shock inside a shelter which resists a direct hit must be taken into account.

Question : Do not some of the photographs of Barcelona show considerable damage to steel framed buildings ?

Answer : I think you will find that they are not really steel framed buildings ; as far as we know, only one framed building in Barcelona has had a direct hit. They are mostly solid masonry types with bearer joists, bearer main beams and possibly a few internal stanchions, rather like the 1894 London Building Act type. If you have a free beam coming down, shaken out of its bearing, it does a great deal of damage, but if you have a frame with rigid connections and the beam is broken it will wilt and bend over, but the connections will probably stand up very well. In Madrid a bomb burst outside the wall at the base of a reinforced concrete framed building and blew away a stanchion completely, yet almost the whole of the building stood up, because the connections of the other beams took the load.

Question : In the case of incendiary bombs, is the heat generated sufficient to melt the structural steel if unprotected and cause damage in that way ?

Answer : Yes, if the bomb is in contact with the steel.

Question : Is there anything to choose between steel framing and reinforced concrete framing ?

Answer : I do not think so.

Question : Does the modern high explosive bomb have more than one detonator ?

Answer : A case has been reported in which a bomb appeared to have had a double explosion, exploding soon after impact and again considerably further down the building. It may be that it broke up and half of it went further on. I have heard no evidence that anything with a double explosion effect has deliberately been constructed.

Question : Is there any sort of accepted or average angle at which the majority of bombs may be expected to fall ? That must affect a good deal the approach to the construction in the matter of resistance.

Answer : I gave an angle of 17.5 deg. for a bomb falling from 12,000 ft. Above that the curve flattens out very considerably, and over London at any rate we may expect the bombing to be carried out from very great heights because of balloon barrages and so on, so that on the whole we may expect the bombs to arrive at a steeper angle rather than a flatter one. Probably the angle will be between 15 deg. and 20 deg. from any of the greater heights, though I speak without expert knowledge.

Question : What effect has the ordinary tile roof ?

Answer : It does not stand anything, not even the light incendiary bomb, though that might ricochet off if it came down at nearly the exact angle of the roof.

Question : Would it act as a burster ?

Answer : I believe that the effect was negligible in tests which were carried out ; it went right through.

Question : Will you be giving any recommendation with regard to reinforcement ? Most architects are not engineers, and it might be useful to have some general rules, even if they were not universally applicable.

Answer : Neither am I an engineer. I do not know of any designs in the matter of reinforcement apart from some which are being undertaken by a member of the Structural Precautions Committee on behalf of the Office of Works for bursting and demolition slabs for telephone exchanges. The Institution of Civil Engineers have just set up a Structural Precautions Committee which I understand is going to pursue this aspect of reinforced concrete design, and we shall probably obtain some information from them.

Question : What effect will a bomb have upon foundations ?

Answer : The effect on foundations is not likely to be very great, unless a delay action bomb bursts in the foundations and breaks them up.

Question : Is the blast pressure from a bomb equal all round the bomb, or has it direction ?

Answer : Theoretically it is equal all round, but in practice, owing to the presence of obstructions, it tends to take directions, particularly in streets and among buildings.

Question : Does the type of paving in the roadway affect the blast effect of the bomb ?

Answer : Yes. A hard surface acts as a burster course, and soft ground all round a building is obviously better than hard roads. A bomb bursting in soft ground will have its

splinter effect considerably reduced and there will be a tendency for its blast effect to go upwards, whereas if it bursts on a hard surface the blast effect and splinter effect are more horizontal and more damaging to buildings.

Question : In view of the beneficial effect of soft ground, why not have soft roofs ?

Answer : That was my point when I said that a really solid resistant roof would be a bad thing. Superimposed layers of floors are in effect a soft roof.

Question : In *The Times* of 7 June it is stated that a method of protecting houses in Canton from bombs by building bamboo framing and scaffolding over them has proved successful. Has there been any investigation into the possibilities of steel nets over buildings ?

Answer : Yes, and it has been found that nets are quite useless against the tremendous penetrative effect of the heavy bomb. The scaffolding referred to would probably do a good deal to protect a building from flying paving stones and so on.

Question : Why cannot you obtain from the same bomb delay action and extreme blast effect ?

Answer : Because the blast effect depends upon the bursting of the bomb with as little penetration into the ground as possible. The maximum air blast effect is obtained when a bomb goes off instantly on touching a hard surface ; the more it penetrates, the more its blast effect is dispersed in the earth.

Mr. SCOTT : One answer is that bombs are constructed for special purposes. The bomb which is designed to give the maximum blast effect, and which would probably be used against buildings, is the general purpose bomb, and the 500 lb. general purpose bomb would probably contain 25 per cent. of its weight in high explosive. A bomb with a delay action fuse, designed to penetrate into hard substances before exploding, must of necessity have very thick steel walls, strong enough to pass through concrete without breaking up. A light case bomb would probably collapse on striking a series of hard floors and therefore not explode. A semi-armour-piercing bomb, therefore, has an explosive charge of only 10 per cent. of its weight, so that the blast pressure of the explosion must of necessity be very much less. It is impossible to obtain both maximum effects in the same bomb.

Question : Is there any special reason for adopting a distance of 50 ft. for the figures given in relation to the 500 lb. bomb ?

Answer : I do not think so. The tests which have been made were done at that distance, 50 ft. happening to be adopted as a standard.

GENERAL PRINCIPLES AND STANDARDS OF PROTECTION

Mr. T. E. SCOTT : This subject is a new one to all of us. It was quite new to me two or three years ago, and even now I do not pretend to know a great deal about it. There are many matters which will stand repetition, because I feel that architects have to absorb these principles into their blood, so that they take account of them automatically, just as they do in the case of the provision of light and air and access and so on, in their buildings.

Another question to which I should refer is that of standards. We have tried to devise a sort of standard specification of protection. We cannot anticipate the size of the bomb that is going to be dropped. We do not know where it is coming from, and in fact we know little about it. It is impossible to design against all conceivable points and forms of attack. We have had to try to make recommendations which cover all reasonable contingencies without converting buildings into fortresses and making them useless for any peace-time purpose. There is not an answer to every one of the problems which some of you put up, and what we are trying to do is to give you the best answer to meet the ordinary needs of buildings. Where there are special problems, or buildings which demand very special protection, we can hardly give an answer at a moment's notice, and in fact there may not be an answer.

I would ask you to keep that standard of protection very much in mind. The question came up, for example, when Mr. Bird was asked why a distance of 50 feet from the bomb was selected. A distance of 20 feet or 100 feet might have been chosen, but 50 feet was decided on as being a reasonable assumption. If we had adopted a distance of 10 feet, and endeavoured to devise protection against a 500 lb. high explosive bomb bursting 10 feet from the wall, we should have had to make recommendations which you would say were impossible ; we should have had to suggest brick or concrete three or four feet thick, and other measures which, even though architects might be willing to adopt them, their clients could not afford. All the way through we have tried to devise a certain standard of protection, but the standard of protection afforded to the occupants of a shelter may in fact be increased automatically because of the nature of the building ; but that is something which is peculiar to individual buildings, because, although the protection provided in the basement of a ten-storey building is desirable, and may perhaps be considered adequate, if your client requires a two-storey building he is not likely to add another six or eight storeys on top of that in order to achieve the degree of protection desired.

This morning I propose to refer only to certain general principles, and I shall deal with certain protective measures separately. In the application of these protective measures you will find it necessary to achieve some sort of compromise, weighing one with the other having regard to the nature of your building in order to arrive at your own conclusion.

So far as high explosive bombs are concerned, I hope it will be agreed that complete protection against direct hits cannot be designed in terms of normal construction in buildings, but account must always be taken of the cumulative resistance of a series or sequence of reinforced concrete floors and roof slabs. Floor slabs, if of solid reinforced concrete construction as opposed to any

hollow system, may have the effect of detonating a large bomb before it reaches the lower floors of the building. I say "may" because if the bomb is of the general purpose type it will be detonated fairly soon, but if it is of the semi-armour-piercing type it may penetrate a large number of floors before exploding. On the other hand, due regard has to be paid to the effect of the steel members in a framed building. Looking up at a skeleton structure before it has any covering on it, you will have been impressed by the fact that you can hardly see the sky for steelwork; and I think it is improbable that a large bomb will find its way right through a building without striking one or other of the steel members. I mention that because it does indicate that the protection afforded in the basement of a multi-storey building is likely to be far superior to that found elsewhere.

As a general rule it is sound practice to use the thickest possible concrete floors consistent with practical requirements, subject always to the need for minimising the damage which might be caused by demolition effects. A very large proportion of the casualties in Spain have been caused by the collapse of the upper parts of buildings on to basement ceilings or floors which are not strong enough to carry the load; and, if you have taken reasonable precautions to keep the small incendiary bomb out of the building and to burst the high explosive bomb as high as possible, it is most reasonable in terms of air raid precautions, and certainly in terms of building finance, to use as a general rule, in the case of the intermediate floors, normal and, if desired, hollow tile construction, in order to reduce the weight of debris which might fall on to the roof of a shelter.

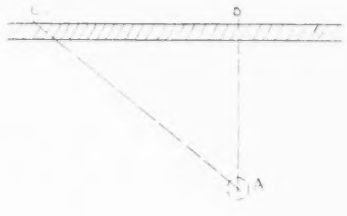
I should like to emphasise, however, that in our opinion it does not appear either desirable or practicable to prescribe any form of construction for normal building works for which may be claimed the property of resisting the penetration of even medium-sized high explosive bombs. You may be able to design a floor slab which will keep out the smallest type of high explosive bomb which we believe to be made, the 25 lb. bomb, but we cannot legislate for that; we cannot instruct a potential enemy to be good enough to drop 25 lb. bombs, and the probability is that the bombs which are dropped will be very much larger, sufficient to demolish the floor or roof slab, and you do not want to increase the damage by having excessively thick chunks of concrete hurtling down through the interior of the building.

There is another point which has emerged from our examination of the problem, and that is that the force of impact of a bomb is so tremendous that even if it were possible to use a sufficiently thick roof slab on a building to resist penetration, the blow of impact from a large high explosive bomb would be so great that the additional loading would probably cripple the steel or concrete framework supporting that heavy roof slab. Mr. Bird quoted the spectacular figure of several million pounds as representing the possible load of impact of a large bomb on a roof slab, and no steel framework could normally be expected to resist such a load, so that, even if you did succeed in keeping out a large bomb, the whole of the building would probably collapse, with perhaps a six-foot-thick slab of concrete coming down on top of everyone underneath.

We feel, therefore, that in a framed building, and also in a solid wall building of normal construction, there are advantages in the cumulative powers of resistance of a sequence of normal floors, as opposed to the construction of a single floor of tremendous thickness, which would be of doubtful value and which might incidentally fail to serve its purpose, because the bomb might come through a window instead of through the roof.

Questions have been asked about foundations, and I should like to refer to that point. Frankly, we do not know a great deal about it, except that it is the considered opinion of experts both in this country and in Germany that it is impracticable to take any special steps to provide additional protection for foundations. The view is that if a large bomb does happen to strike the foundations of a building, no precautions of a structural nature which are practicable in terms of building finance would be of any use at all. Something is going, and it is not so much a question of providing bigger foundations as of being unable to do something about the earth underneath the foundations.

Mr. Bird gave a table showing the thicknesses of various materials which would afford protection against splinters from a 500 lb. bomb at 50 feet. Those thicknesses represent more or less absolute protection, and I think it is correct to assume that only at the more vulnerable points might such walls at times be penetrated. If a bomb bursts at *A*, 50 feet from a wall, the most intense effect would be at *B*, and even a short distance away, as at *C*, the penetrative effect of the splinters would be less and the thickness of wall in the direction of the path of the splinter greater, so that the more serious effects are likely to be felt only at the point *B*. Apart from that, the explosion and fragmentation of a high explosive bomb are such that the more intense effects are at right angles to the path of a bomb, with additional small areas for the effect of the nose and tail.



We shall suggest later on that it is necessary to provide protection against fragmentation by the provision of walls of suitable thickness as near as possible to the protected accommodation. If you have basement or ground floor protected accommodation, and you have shop windows or large windows on either side of the building, it would be impossible to provide sufficiently thick walls outside the building, and you may have to decide to provide your protected accommodation in a corridor or in some room away from the external walls. In some cases, and particularly in the case of a small house or building of the domestic type, it may be necessary to take advantage of the combined thickness of walls, and up to a point that may be done ; i.e., a 4½-inch wall and a 9-inch wall will probably give the same ultimate degree of protection as a 13½-inch wall, but that depends to some extent, of course, upon their nearness.

Some reference has been made to the protective value of the reinforcement of concrete both against blast and against penetration by splinters. We do not know a great deal about it, but most of the experiments which have been carried out suggest that it is better to use small reinforcement closely spaced than large reinforcement at wide intervals.

So far as types of concrete floors are concerned, I suggest that any type of hollow tile floor will not give the same amount of protection against penetration or anything else as a solid reinforced concrete floor of equal strength ; and of the various types of solid reinforced concrete floors I would suggest those with reinforcement of small dimensions running in both directions rather than in one direction only.

The question of blast has been mentioned by Mr. Bird, and he has anticipated all that I would wish to say at this juncture. Walls of the thicknesses given in his table might be expected to resist blast pressure up to the standard which we envisage, i.e., from a 500 lb. bomb bursting 50 feet away. That assumption, I think, has been proved fairly conclusively, but further tests are being undertaken to find out whether there is still a satisfactory margin of safety and whether we could, at a pinch, recommend either a more satisfactory form of construction of walls of those thicknesses or, alternatively, a wall of less thickness. The peak pressure of a 500 lb. bomb at 50 feet is in the region of 41 lb. per square inch, which is very considerable compared with the normal wind pressure for which we provide in the design of tall buildings.

Up to date we have not been able to make any recommendations for the protection of windows against the effects of blast pressure. A very large number of tests has been carried out. Glazed window frames have been subjected to blast pressure from the equivalent of a 500 lb. bomb ; windows have themselves been protected with sheets of three-ply, and have been covered on both sides with sheets of cellophane ; some form of Triplex glass has been used, and in some cases a sheet of steel has been fixed over the outside of the window ; but in no case has it been possible to protect the glass against blast pressure. In one or two cases where rather stiff materials have been used instead of glass, for example three-ply, the three-ply has not been blown out of the window frame in the first instance but the window frame has been blown out of the wall ! I think we have a long way to go—indeed, an endless journey—before we can make any useful recommendations about windows, except that so far as I am concerned, if at all possible, I should be inclined to take the windows out on the threat of war, because otherwise the glass will certainly be blown out, and in some cases the window frames themselves may also be blown out. I think that the best precaution to adopt is to take the windows out, and, if not, to open them, and then to provide a light frame, possibly covered with canvas, which can be lightly wedged into the window opening so that it would be dislodged by blast pressure and could then in due course be put back again. There is no golden rule and no principles of construction or design which will enable you to save windows.

Reference has been made to the degree of resistance of leaded lights, and experiments have shown that leaded lights are able to resist blast pressure better than ordinary glass. They would probably not stay in position at a distance of 50 feet, but if used high up in a building or subjected to blast pressure from a bomb bursting 200 feet or more away, leaded lights will probably stay in position rather longer than windows glazed with sheet glass.

Research and reports from abroad indicate that all sorts of projecting architectural features may be very readily dislodged or destroyed by blast pressure. Features such as coping stones, cornices and eaves and other overhanging features can in some cases be sheared right off or just pushed over and knocked off. The same will apply to features such as porticoes, arcades and other architectural features, the stability of which depends upon bearing pressure rather than upon some form of structural framework. If, therefore, you wish to design a building having an arcade or portico or some such feature it is better to build that feature with a steel or reinforced concrete framework rather than rely upon the bearing pressure of one stone upon another.

Bombs bursting nearer than 50 feet to a building may exert tremendous blast pressures, and, as I have suggested, it is not possible to design against such extreme cases ; but as a general rule it may be taken that a steel or reinforced concrete framed structure, rigidly braced and with strong joints between all structural members, and with light panel walls, will be less liable to serious damage or complete demolition than a building having solid load-bearing walls. In the case of a bomb bursting inside the building, the blast pressure will obviously be confined by the external walls and the effect of the explosion will be far more serious, but the same principle would seem to apply.

A framed structure with comparatively light wall panels, and possibly with large windows, would naturally be very seriously damaged ; conceivably the external wall panels would be blown out, some of the floors might be destroyed, and the building might in fact be so seriously damaged that it would be quite unfit for human habitation afterwards. That, however, is not the end of the story. Such a building, although useless for further occupation, might still afford some protection for people sheltering in the basement. If any structural precautionary measures which we are able to adopt serve to keep most of the building up while these people can be got out, before they are crushed to death in the shelter, then those structural precautions will have been worth while. That is one of the principles to keep in mind. It is not possible to ensure the complete safety of a building regardless of what happens, but what you do may give somebody a better chance of safety, and that should always be kept in mind when attempting to apply these principles to the design and construction of buildings.

This effect of demolition, which is so serious, can be reduced by the adoption of some of the principles which I have explained and will explain, and it can be minimised by avoiding heavy architectural features such as towers and large chimney stacks which are not tied in properly to the structural framework, and insufficiently supported or badly placed water towers and heavy machinery. I am not going to suggest that your architectural prejudices should be changed because of structural precautions, but I am suggesting that you should keep in mind the fact that heavy architectural features high up in a building may constitute a serious danger in time of war, and therefore you ought to see to it that their construction is such that they will not be readily dislodged by shock or any other effect of attack. Nor do I suggest that you should at once discontinue the installation of large water storage tanks, but it may be considered desirable to see to it that they are so located in the building that if they should be brought down they will not fall immediately on top of the protected accommodation. Further, it may be considered desirable to provide for the speedy emptying of such tanks on the threat of war ; if empty, they will not constitute nearly so serious a danger as when they are full.

In multi-storey buildings which have these substantial architectural features high up above roof level, the topmost storey should have a particularly strong floor, strong enough to sustain the load of these features if they are demolished. Reports from Spain indicate that in very many cases serious damage has been caused by these indirect effects of demolition, which have disturbed and dislodged a large chimney stack or architectural feature which has toppled down through a building otherwise not seriously damaged by explosion.

Incidentally, the provision of a solid reinforced concrete floor slab or roof slab high up in the building may have the effect of detonating a medium-sized or in some cases a large-sized high explosive bomb, and would also provide sure protection against the smallest incendiary bomb ; the $2\frac{1}{2}$ lb. incendiary bomb will not penetrate a 4-inch reinforced concrete roof slab, and that has been definitely proved. This slab at the top of the building should not, as I have previously suggested, be so thick as to constitute an additional danger if it is dislodged ; it is better to rely for overhead protection on a sequence of solid slabs of normal thickness than to put all your eggs in one basket and provide all the additional strength in one slab.

The next important consideration is the provision of what I call a " demolition slab." I have coined that term myself, and by it I mean a floor slab which is designed to be strong enough to sustain the load of demolition of the building up above. A demolition slab should always be provided over shelter accommodation, or over accommodation in a building which may in time of emergency be set apart for personnel. The exact location of that floor slab will naturally depend entirely upon the nature of the building. As we shall suggest later, the basement is usually the best place in which to provide protected accommodation, but there are some buildings in which it is not possible to use the basement. In some hospitals, for example, it would be quite impossible to put all the patients down in the basement, and it may be that the first, second or even third floor of a hospital building, if a tall building, is the one to which as many patients as possible would be moved. If that decision is reached, then the floor slab immediately over that selected accommodation ought to be strong enough to sustain the load of demolition.

All such floors which are designed to take additional loading due to demolition must be subject to special consideration, and in many cases, if not in most, may have to be specially designed for the purpose ; but as a general guide which may be used in the design of buildings having office or residential accommodation only, the following figures have been adopted by the Home Office for general issue, and there seems no reason to depart from these recommendations.

In the case of buildings of solid construction—i.e., buildings with thick external walls and thick cross walls, and possibly thick partition walls, all of them thick because they have to perform the task of carrying the floors—where there are two storeys over the demolition slab it should be designed to carry 200 lb. per square foot ; where there are three floors, 300 lb. per square foot ; and where there are four floors or more, 400 lb. per square foot, all of those in addition to the normal loading of the floor and the weight of the floor. In framed buildings it is considered that the demolition floor slab should be designed to carry 200 lb. per square foot in addition to the normal loading. The reason for the variation will be obvious ; as a rule in a framed building there are no very thick walls, and the internal

partitions are normally comparatively thin and light ; there is nothing like the same load of structural materials liable to collapse as in the case of a building with solid walls. I have already suggested, and would again emphasise, that special cases will need special consideration. I advise you always to make a special note of the possible ultimate loading of floors with goods and stores and machinery and so on, which might constitute an even greater danger than the weight of the building materials themselves.

I said that we would deal with all these factors separately, but that we should have to effect a compromise a little later on, and now I will refer to incendiary bombs and repeat that a solid reinforced concrete roof slab 4 inches thick will resist penetration by a 2½ lb. incendiary bomb. Roof and floor slabs of normal construction would not separately provide protection against the 25 lb. incendiary bomb, which is a size which may be used, but collectively two or three floors would probably retard and ultimately stop the bomb, thus confining the resulting fire to an upper floor. It may be possible in some cases to design a thick enough floor to keep out the 25 lb. bomb, and research which has been carried out suggests that an 8- or 9-inch reinforced concrete slab would probably do so, but we are faced with the problem to which I have already referred : the blow of impact of a 25 lb. bomb falling on a roof slab is so considerable that very exceptional structural precautions would have to be taken in the design of stanchions and steelwork to carry such a slab and to resist such a blow, and it therefore seems outside the bounds of practical politics. It is probably best so to dispose the contents of the building and the nature of the accommodation that if it is desired to afford this greater degree of protection against incendiary bombs the more vital accommodation may be placed below the second or third storey underneath the roof, so as to take advantage of the cumulative powers of resistance of a series of floor slabs rather than to rely on one.

Particularly in single-storey buildings of vital importance, however, it may be possible to provide adequate support for a 9-inch roof slab at frequent intervals without considerable expense, and furthermore it is obvious that if a 9-inch or even thicker reinforced concrete slab is used near to the ground the dangers of demolition are comparatively slight, and it is a risk which you and your clients may be prepared to run in exchange for the additional security afforded against the larger incendiary bombs.

Roofs of timber construction having a covering of slates or tiles will not normally resist penetration by even the smallest incendiary bomb. In some cases the steeply pitched roof might have the effect of diverting such a bomb, but on the other hand it might have the effect of catching it when the angle of the bomb was normal to the pitch of the roof. Roofs of such construction, however, may so retard a small incendiary bomb that in almost every case it would be brought to rest on the attic floor, where it would ignite. In many buildings, of course, the incendiary effects of even a 2½ lb. incendiary bomb would be sufficient to ignite the roof timbers, but I have seen a number of tests carried out with these bombs on modern roofs, and although in some cases the incendiary effects would be very serious indeed I think if people keep calm it should usually be reasonably possible to extinguish the fire. Wood roofs do not burn as quickly as some people imagine. In some tests which were made I saw model roofs—I say " model," but they were built of full-sized timbers—which appeared to burn fairly fiercely, but they were extinguished with a bucket of water without any difficulty. If, therefore, in domestic and other buildings where timber roofs are used and it is possible to get at the roof space easily, it ought not to be too difficult to put out fires, unless the attic spaces are filled with rubbish. In Germany there is a strong recommendation, and possibly a regulation, that provides that roof spaces should be cleared of lumber.

There are some materials which may be used on attic floors to resist the incendiary effects of these bombs and confine the fire to the roof. I have not seen asbestos cement sheeting tested, so that I cannot speak of its usefulness, but I have seen a material called Durasteel used, and that did quite definitely resist the incendiary effects of about 5 lb. of thermite—the equivalent of a 2 kg. incendiary bomb—without any difficulty whatever. No doubt there will be other similar materials on the market which will achieve the same object. There are other precautions which will suggest themselves to you. It may be possible in some cases to put a very thin layer of fine concrete on the attic floor, just sufficient to resist the incendiary effects of bombs —not to resist penetration, because it would not ; but the penetrative effect of the bomb is usually taken up by the tile or slate roof. You will probably all remember the recommendation that an attic floor should be covered with 2 inches of sand. Personally, I think that that is rather worse than useless, because a bomb dropping through the roof would disturb the sand and form a little pocket in which to burn its way through the floor. I will conclude this reference to incendiary bombs by suggesting that the kind of fire-resisting construction with which you are all familiar should be adequate so far as protection against incendiary bombs is concerned.

With regard to gas bombs, my own view is that protection against gas so far as buildings are concerned —I am not in any way belittling the efforts of the Home Office in providing people with gas masks, in providing decontamination centres and in training Red Cross and other workers, precautions which are very necessary—has caused a good deal of confusion in the public mind. As I suggested last night, if a gas attack were likely to be made without the use of high explosive bombs, it would be very easy to provide protection.

I am assured by scientific friends that it is physically and chemically impossible to drop enough gas to constitute a really serious menace to life over a large area. A gas attack would be annoying and that is about all, though it would be serious for the limited few, of course, who were caught by the near effects of a large dose of mustard gas. Nevertheless, we have to assume—and we assume it on the very best authority—that even if gas is used at all, only a very small percentage of the bombs would be of that type, and probably at least 90 per cent. would be high explosive or incendiary; and the high explosive bomb has the unfortunate effect of destroying almost every gas-excluding device that we can think of, short of the more substantial precautions which we can take in reinforced concrete or other really good shelters.

Although I make that suggestion, I do want it to be realised that where it is possible to take precautions against gas, particularly in new buildings, those might well be taken, because what has to be done in a well-constructed building is very simple. It may or may not be necessary to devise some form of mechanical ventilation; that we shall refer to later on.

There are other aspects of a gas attack, however, which ought to be kept in mind, particularly in connection with stores and ordinary rooms which may not be occupied during an air raid. Mustard gas, even in very weak concentration, is a serious danger if it comes in contact with food; and in time of emergency people might hurriedly leave their living rooms and kitchens without thinking of the food and other materials left about, and after finding complete safety in a shelter they might quite unsuspectingly return to their living accommodation and undo all the good which had been done by the shelter by consuming food which had been contaminated. In the design of buildings, therefore, you should always see to it that air bricks are of the type which can be sealed up, and places for foodstuffs should be designed so as to be capable of being made gas-tight as readily as possible.

Some of us at times make rather a fetish of windows. They are not necessary in all rooms, and in many warehouses and similar buildings one sees large expanses of external wall having at least 50 per cent. of window opening, and with the goods piled up against the windows so that for many years the windows have not admitted any daylight. I suggest that a little common sense in the planning of storage buildings might lead to the abandonment of the window in them as a source of natural light and ventilation. Such windows might in war be a source of danger; windows would be very quickly destroyed and it would become almost impossible to exclude gas; even if gas were used in quantities not large enough to constitute danger to human beings it might be sufficient to contaminate food and other materials which were being stored. I put that aspect of the gas problem to you as one of the really serious ones. I hope I shall not be proved wrong, but I do not believe that many individuals would be incapacitated by a gas attack; I do think, however, that there are these other aspects of contamination which must be considered quite seriously when designing buildings.

Incidentally, mustard gas does readily penetrate and contaminate all absorbent materials, and a certain amount of amusement and annoyance was caused in the early days of structural precautions when it was suggested by someone—not an architect—that white glazed brickwork should be universally adopted throughout the architectural profession because it was not absorbent. My own view is that, despite this unfortunate air raid objection to absorbent materials, we need do nothing about it except, I suggest, that if in any building you are deliberately planning the approaches to shelter accommodation and the like, you might in such cases use glazed brickwork, or some other form of non-absorbent material which could, if necessary, be readily cleansed of mustard gas or any other form of poison.

The meeting was then thrown open for questions.

A Member: As an air raid precautions officer for one of the Metropolitan boroughs, I am naturally very interested in what has been said about the protection of glass windows. In my private capacity I went to Barcelona not long ago, and accepted the invitation of architects and engineers there to investigate their air raid precautions. It is astonishing to find how much importance in Barcelona is placed on the simple process of criss-cross pieces of brown paper inside and out; I saw them everywhere and they gave the whole town rather a gala appearance in that respect. Interior glass partitions are treated in the same way.

I was shown by my technical friends in Barcelona some of their most recent underground shelters in the great squares. They are really magnificent, and one would feel absolutely safe in them no matter what type of bombardment it was. They are built in the form of great wide traverses. We have to think in terms of the war-time trench; the traverses adopted by the Spanish engineers are about 20 ft. wide with galleries or tunnels—slits cut into the ground—in between. They have no use for concrete partitions of any kind; there is something about mother earth which makes it suitable as a shock-absorber, as a cushion to the tremendous effects of high explosive bombs. In these shelters they are able to accommodate between 3,000 or 4,000 people simply by adopting this system of wide earth traverses, and it seems to me that if you are asked to construct underground shelters under our London squares, you should bear this matter of earth traverses in mind.

Mr. BIRD: In the A.R.P. Factories Hand Book there are some diagrams of trench systems which are recommended for use in connection with factories.

Answer: We shall attempt to discuss the problem of shelters to-morrow, but one of the difficulties we have in mind in connection with any form of public shelter away from buildings is that of properly organising the approach of civilians to these shelters.

Question: That was not the experience in the War, when air raids took place on London, so far as the use of the Tubes were concerned.

Answer: The Tubes would not be available, and in any

case I think that it is hardly fair to quote the last War. I was in London on leave during a couple of raids, and I went into the streets to look, as many of us did, but what has happened in Spain and China puts us in a different frame of mind. I suggest that the best solution of the problem lies in providing as close to every man's place of work or residence as possible some reasonably protected accommodation, rather than in attempting to provide protected accommodation in certain selected areas. Normally in the residential areas in big cities, I would deprecate the construction of large shelters —either trench shelters or underground garages—as a policy, because I think it would discourage others from attempting to provide their own, and it would be impossible to provide these public shelters for every individual in the community.

Question : With regard to the weight of the superstructure in process of demolition on the floors below, we work to-day to a factor of safety of four. Is it possible to take part of that factor of safety into account in considering the load which might collapse on the floor below ? Is it the type of emergency for which the factor of safety is designed ?

Answer : I should prefer to put in the strongest possible demolition floor which I could reasonably afford. I do not think we are able as architects or engineers to anticipate exactly what sort of loading a floor might have to sustain in the event of demolition. None of the figures which we can give you are exact in relation to some precise loading or some precise impact or some precise blast pressure ; we are only adopting a standard which seems to be reasonably related to the forces against which we may have to contend, and the sort of construction and design to which we as architects are accustomed. I am afraid that, if I am asked to be more precise about the scientific aspect of air raid precautions, I must confess my inability to be so, partly because I am not a scientist, but chiefly because there is nothing scientifically exact about the forces against which we are guarding. We cannot assess exactly what the load of demolition is likely to be. The figures which I have given may be excessive, but, on the other hand, they may be inadequate. They have, however, been compiled as a reasonable standard which appears appropriate in buildings of the two classes I mentioned—solid wall structures and framed structures of a domestic or office type.

Question : In the case of reinforced concrete buildings of the bigger type, where it is possible that a high explosive bomb would burst in the middle of the building, if that occurs many of the members will be subjected to reverse stresses to those for which they are designed ; members in compression will be transformed momentarily into members in tension. Particularly with regard to floors, has any consideration been given to reinforcement at the top ?

Answer : Yes, that was considered, but, generally speaking, the feeling has been that additional reinforcement of that kind would add very considerably to the cost of buildings. It is impossible to anticipate which of the floors might be subject to these reverse stresses, and to apply the principle to every floor in the building would add very appreciably to the cost ; in fact, it would put certain types of floor construction out of court altogether. In the main we have to ignore that as one of the contingencies for which we cannot provide.

Question : What is the area which an ordinary mustard gas bomb will contaminate, and how long will that contamination last ? If food is contaminated once will the contamination continue ? What effect will a 500-lb. bomb have on an ordinary factory chimney ? In what area would the blast of such a bomb affect a large factory chimney ?

Answer : The area contaminated by a gas bomb depends on the nature of the surface on which it falls, on the size of the bomb, and on all sorts of factors which will vary in every case. If it fell in a narrow street, the area of contamination would be determined by the limits of the buildings. The period of contamination likewise depends upon a number of factors, such as the degree of absorption of the material. If a material is very absorbent the mustard gas liquid will be absorbed, and in cold weather it may remain a source of danger for three or four days, because the liquid vaporises quickly in warm weather and slowly in cold. There again, therefore, no exact answer is possible.

With regard to the effect of the blast pressure of a 500-lb. bomb on a tall factory chimney, I think the answer would depend on the nearness of the explosion, and probably on the construction of the chimney and the extent to which it might be shielded to some extent by adjoining or adjacent buildings.

Question : Would glass bricks be in any way resistant to blast pressure, or would they be worse than an ordinary window ?

Answer : I understand that a panel of glass bricks was tested, and the glass bricks were pushed out very easily.

The meeting adjourned at 12.45 p.m. until 2 p.m.

SECOND SESSION

14 JUNE 1938, AT 2 p.m.

APPLICATION OF A.R.P. TO BUILDING PRACTICE

Mr. T. E. SCOTT : I should like this afternoon to make some more special reference to the application of air raid precautions to building practice. In the main, structural precautions will be required to serve three purposes : to afford protection to personnel, to minimise damage to buildings, and to protect the contents of buildings. The importance of these three will vary in various types of building, and it will be found that certain principles of architectural design, such as the provision of large windows where good natural light is essential, may make it difficult, if not impossible, to provide equally for each of these purposes throughout the whole of the building without a good deal of compromise.

I would also point out that the various effects of high explosive bombs appear to demand different treatment —thick walls to resist splinters, and thin walls to yield either considerably or slightly to blast pressure without transmitting a damaging stress to the structural framework. In your buildings, therefore, which will be of

infinite variety of purpose and infinite variety of plan and shape, you will have to devise some sort of compromise in the application of these principles to your own problems. I propose this afternoon, however, to refer to certain aspects of building, such as planning, in order to take account of a variety of factors.

In referring to new buildings, I should like again to make it clear that there are so many varieties of construction and size that what is good for one may not be good for another, and what is possible in one building may be quite impossible or impracticable in another type. I have had to confine most of my remarks, therefore, to what one may call the bigger buildings, which may be of framed construction, and are usually of fire-resisting construction throughout. Certain further references will be made to small buildings of a more traditional form of construction a little later on.

The general recommendations which I shall make are intended to afford that degree of protection which we may look on as in the nature of our standard : first of all, to provide resistance against penetration by the smallest incendiary bombs ; secondly, to prevent or minimise the spread of fire caused by incendiary bombs ; thirdly, to prevent or to minimise damage to buildings by high explosive bombs of 500 lb. weight bursting at a distance of not less than 50 feet from the building, and if possible to minimise the damage done by similar bombs nearer to the building ; fourthly, to reduce the damage caused by the demolition of the upper part of the building ; and, finally, and most important of all, the protection of persons sheltering within what we should call protected accommodation against all effects of aerial attack except a direct hit from any but the very smallest of bombs.

They are the things which we set out to do in devising these recommendations. As I have said before, the contingencies of attack are so varied that our precautions cannot be scientifically correct. Their efficacy will be increased or decreased according to the nature of the attack or to the other conditions in the building to which they are applied. As a rule, in larger buildings I think we may take it that the precise degree of protection which would be afforded would be greater than that which I have just scheduled.

The first aspect to consider is that of planning. For quite a long time we have regarded the small totally enclosed courtyard as a source of potential danger, both because at one time the poison gas risk was, I feel, rather exaggerated, and, secondly, because we were quite mistaken, I believe, in exaggerating the chances of a high explosive bomb finding its way down into the inside of a building through a small totally enclosed courtyard ; hence our original recommendation that these courtyards should be avoided. You may wish to avoid small internal courts for other reasons which I shall not discuss, but so far as structural precautions are concerned, we have now come to the conclusion that these courtyards do not of necessity represent a serious source of danger. I enlarge on that because some reference to the small courtyards in question may have appeared in previous recommendations and publications of the Home Office. The reason why we no longer regard them as a serious source of danger is that it is almost certain that any bomb dropped on a city like London would fall at such an angle that even if it did enter the top of a very small internal court or light well, it would almost certainly strike one of the side walls of the court, and not find its way down immediately into the interior of the building.

As Mr. Bird has explained, the damaging effects of high explosive bombs will be increased according to the closeness and height of adjoining buildings. We therefore suggest that where the area of a site permits freedom of planning, closely confined spaces should be avoided, and open spaces around buildings and in courtyards should be as evenly distributed as possible. Where the planning requirements permit, a compact multi-storey building is usually to be preferred to a low building spread over a large area, assuming, of course, both buildings to provide the same total area of floor space. The tall building affords a smaller target, and will incidentally usually provide much better protected accommodation in the lower floors, providing that arrangements are made to ensure protection against the effects of demolition. In cases where a considerable area is to be covered by a building, and where the planning requirements permit, and even involve an open plan on a large site, the wings should be spaced as widely as possible. That is probably a principle of planning which we should nearly always observe quite regardless of structural precautions, but it is interesting to comment on its suitability so far as this purpose is concerned.

Another point which arises only in isolated cases is the disposition of groups of buildings, as in large factory schemes, where it has been felt, subject to the recommendation of those in the Air Force who should know, that easily distinguishable patterns of buildings ought in some cases, and particularly in the case of important industrial concerns, to be avoided. In the first place, if the pattern is readily distinguishable, it is to be assumed that an intelligent enemy would be able to recognise it more quickly than we should wish, and, secondly, some types of regular pattern in building might form a very much better target than others ; for example, it should not be difficult for an attacking air force flying down in the direction of the Great West Road to drop bombs, some of which, at any rate, must hit one or more of the buildings because they happen to be in a straight line ; whereas if the buildings are irregularly disposed, the chances of a hit are reduced very considerably. Those are points of planning, however, which can obviously affect only very few of us.

With regard to general construction, it is suggested that, where economically practicable, buildings should be constructed as framed structures in steel or reinforced

concrete, this form of construction being less liable to complete collapse than one with solid load-bearing walls. In many cases, practical requirements will make it quite impossible to depart from normal or special spacing of stanchions, but in the main, it will be appreciated that the wider the spacing of stanchions the greater the risk of serious demolition in the event of a vertical support being destroyed by a direct hit. The joints between frame members should be as rigid as possible, and that applies equally to steel-framed structures and to reinforced concrete-framed structures. In buildings of the solid load-bearing type, if the floors are well bonded to the walls, and in a framed structure if the floors are homogeneous with or rigidly secured to the framework or walls, the building will very much more satisfactorily withstand the effects of blast pressure.

I have already referred to the advantages of this framed type of building with comparatively thin panel walls, and that recommendation may be taken to apply in general to all types of building. The advantage of the thin panel wall is twofold ; in the first place, it is thin enough and weak enough to yield to intense blast pressure without exerting or transmitting that damaging stress to the steelwork, and incidentally a thin slab of material, a thin wall, may yield just that little bit which is necessary to prevent collapse. The research undertaken at the Building Research Station does suggest that if the structure can yield momentarily while the blast pressure reaches its peak—i.e., in very much less than one-thousandth part of a second—it can probably survive the whole of the shock ; but if it refuses to yield that little bit it will probably be destroyed. Some measure of elasticity is an advantage when designing to resist blast pressures. That may sound very strange, but we are assured that it is true, and a number of tests which have been carried out prove that to be the case.

So far as fire resistance is concerned, it is sufficient, I think, to suggest that normal fire-resisting construction should be adopted in every case. Where timber is to be used you will naturally be wise if you refrain from employing it in any position where its destruction might lead to serious demolition. The days of wooden lintels and so on are fortunately past, but if you are tempted to use timber in such positions, you might pause to think of the consequences if incendiary bombs should be used in any future war. As a rule, timber is employed only in very small buildings where, for economic reasons it is not practicable to use concrete or steel, but I suggest that where you are permitted by the bye-laws and required by economic considerations to use timber for your floor construction, generally you should consider the advantages of at least using a reinforced concrete roof slab four inches thick ; it might in time of emergency prove a tremendous advantage. It should be unnecessary in these days to remind those who build terraces of houses that the party walls ought always to be taken up at least to the underside of the slate or tile roof covering, and not finished off at the level of the topmost ceiling, as is sometimes the case.

In buildings of steel and concrete construction, I repeat that the roof slab should always be of solid reinforced concrete, having a minimum thickness of four inches, in order to resist the penetrative effects of small incendiary bombs. One interesting point emerged from our discussion of this problem with a member of the research department at Woolwich. I asked him whether he thought that the screeding which we usually employed on a flat roof would, by providing additional thickness, increase the powers of resistance to penetration. He said that he did not think it would, but I am afraid that I find myself unable to accept his decision, and one or two small points have arisen in connection with the research which do indicate that a reasonable screeding on a flat roof will in point of fact increase its power of resistance. In any case, I think that four inches is reasonable enough as a general recommendation, and it will at least have the effect of keeping out the small incendiary bomb, and will prevent the spread of fire.

If you desire additional protection in the roof slab, it may be achieved, as I have previously suggested, by using a 9-inch reinforced concrete slab, which thickness I mention because it is known that it will, if properly supported, resist penetration by a 25-lb. incendiary bomb, and it might in some cases be expected to detonate a small high explosive bomb. If you use such a roof on a single-storey building it might with advantage be constructed entirely of reinforced concrete, with reinforced concrete walls 12 inches thick, and if the whole is cast homogeneously with good haunching at the connections between the walls and the roof, I think you would probably produce a building which would withstand some of the even more intense effects of blast pressure, and which would certainly provide a satisfactory standard of protection against splinters, and in a comparatively cheap fashion would give just that extra security which might be needed in connection with power-houses, telephone exchanges, and the like, which are so vital to the continued working of large industrial concerns. It is a form of construction which is probably impossible on economic grounds for the whole of the buildings, and in any case for the rest of the buildings you will need large windows, top lights, etc. ; but in certain parts of a building, or group of buildings, you may be able to use this greater degree of protection.

It is probable that in even more important cases the use of two roof slabs supported independently—that is to say, with separate girders, if girders are required—and 9 inches thick, would give even greater protection, and, if some two or three feet apart, might afford protection against high explosive bombs of quite reasonable size. I am not making that as a definite recommendation ; I make it as a suggestion for your consideration, because it is a line which is being pursued in connection with a number of Government buildings.

and very careful research is being undertaken in order to find out whether the use of a double roof of that kind will not afford a very considerable degree of protection.

With regard to floors, I have already suggested that you may not find it practicable for economic reasons to make all your floors of solid reinforced concrete, and to make them all strong enough to withstand the loads of demolition ; in fact, if I were to make such a recommendation to-day, I am afraid that many of the manufacturers of the various patent types of floor would object very strongly. Quite apart from any fear of the consequences, however, I do suggest that there does not appear to be any reason why the ordinary floors throughout a building should not be constructed in whatever manner you may think fit. There are the advantages which I mentioned this morning, that the lighter types of floor construction will not, or may not, create such great difficulties in the event of demolition, but incidentally, of course, they would not offer the same degree of resistance of a cumulative kind to the penetration of large bombs.

In ordinary buildings the roof, as I have suggested, ought to be at least four inches thick, but if the building is one having important architectural features—a tower, or even some parts of the building higher than others, parts of the building which may constitute a danger—then it is suggested that the floor of the topmost storey ought to be constructed as a demolition slab ; that is to say, as a slab which would be strong enough to support the weight of any architectural features or excrescences, strong enough to support the weight of the roof slab, if that should be demolished by a bomb bursting at roof level, and to support the weight of anything else which might be damaged or dislodged at that high level. Incidentally, where it is used it may provide an additional bursting slab, which may have the effect of detonating a high explosive bomb at that high level before it gets down into the building. Apart from these two precautions—the 4-inch roof slab and the possibiilty of a demolition floor slab immediately under the roof—I suggest that the other floors right down to the shelter accommodation might well be of normal fire-resisting construction.

There are exceptions which will occur to you in regard to your own particular buildings, and for obvious reasons I cannot possibly take account of all the contingencies which practice will offer. For example, in some buildings it is necessary to consider the location of heavy machinery. We all know buildings where, for reasons best known to themselves, the building owners have required heavy machinery to be installed on the upper floors, and it needs no great amount of imagination to visualise the potential danger of such a practice in the event of the slightest damage to any of the members supporting these heavily loaded floors. I suggest that where practicable the placing of heavy loads on upper floors should be avoided. You will save money and you will reduce the risk of serious demolition effects. But where heavy loads must be placed on upper floors, all the floor slabs below will have to be very carefully designed, not merely to carry the loads of the actual superimposed machinery, but the possible additional loading of machinery on upper floors, which might amount to something very serious.

The exact location of additional demolition slabs will depend on the position of shelter accommodation. I suggested this morning that in some buildings, such as hospitals, it may be necessary to put the shelter accommodation on an upper floor, in which case the floor slab immediately over this protected accommodation ought to be strong enough to support debris from above. The most important demolition floor slab in the whole building, to my mind, is that which should be placed over all protected accommodation. I shall go more fully into this question of protected accommodation to-morrow morning—its exact location, its equipment, and so on—but I do visualise protected accommodation as something which is an integral part of the building, and therefore we must consider its construction here and now.

This demolition floor slab should be capable of carrying the loads which I gave you in the schedule this morning, and it should be placed not only over the actual rooms which are set apart as shelter accommodation, but also over all the corridors and staircases which give access to that accommodation. The best shelters in the world will be useless if people cannot get out of them, and it is very important that all means—and that includes alternative means—of access should be at least as strong as the shelter itself.

With regard to the external walls of the building, I have referred to steel-framed buildings with thin walls, in which case the thickness of the panel walls is usually prescribed for you by building regulations. I referred to the thicknesses necessary to provide protection against splinters, which means a 13½-inch brick wall as a minimum, or a 15-inch mass concrete wall, or a 12-inch reinforced concrete wall. I think that the ideal combination would be the steel-framed building having these thick walls, with the smallest possible windows, at least up to the first floor level, i.e., something in the nature of a solid concrete or brick and concrete box, with thick walls and a thick roof, somewhere in which people could go in time of emergency, and then with the rest of the building perched up on top of this box consisting, if you like, of a " birdcage " something in which the smallest possible amount of building material is used, and which approaches a mere skeleton as nearly as possible. That gives you the type of building which is best likely to resist even serious effects of high explosive bombs, but you must not ignore this need for thick external walls immediately around the accommodation used for shelters.

With regard to doors and windows, I have already suggested that so far as the actual window opening is concerned, we can make one really useful recommenda-

tion, but that is not the whole story. The window opening itself must be regarded as to its shape and location to minimise the danger which it might otherwise involve. In general, it is suggested that in all rooms where some measure of protection is necessary, sill levels ought to be as high as possible. That sounds rather like a throwback of twenty-five or thirty years, and we are not suggesting that a sill level something like four or five feet high should be a standard of architectural design ; but we are suggesting that in those rooms in a building where it may be necessary in time of emergency to afford some degree of protection, and in those rooms where a high sill level does not appear to matter very much and does not impair the efficiency of that part of the building, it may prove a very useful precaution. We have in mind the high sill level, for example, in a protected room in a small house. No one would wish a small house—or even a large house, for that matter—to be distorted and to lose all its character because of aid raid precautions, and for one thing, clients would not put up with it. We wish to retain that measure of freedom and ingenuity and individuality in the design of houses and other buildings which we all desire, but there is surely no reason why one room in the house—the kitchen if you like—should not be designed to function efficiently and still take account of some of these principles of air raid precautions. That is why I suggest that we should have the high sill level in mind as something suitable for just one room in a house. That is one of the precautions which Mr. Bird will amplify tomorrow. In point of fact, the need for the high sill level to afford protection against splinters decreases as you go higher up the building, because the chances of splinters entering at a level at which they are likely to do serious damage decreases as the storeys mount above street level.

There are several general features in buildings to which some reference must be made. Roof lights obviously represent a source of very considerable danger, because they are not only extremely vulnerable to small bombs, to fragments of bombs, to anti-aircraft fire, to machine-guns, and in fact to everything, but they may also be very easily damaged by blast pressure at considerable distances. Despite all these war-time disadvantages, however, I do not think the answer is to abolish the roof light ; you simply have to make the best of it. In many buildings—industrial buildings and so on—the roof light must be looked upon as a peace-time necessity which we are not going to do without ; but there may be cases in other types of building where a roof light is something of a luxury ; it is a feature in design which may not be absolutely essential. I am thinking, for example, of the roof light over a large staircase. In many cases a large staircase with large landings may be capable of becoming the best protected accommodation within a building, particularly in the case of blocks of flats, but the usefulness of the staircase ower as a shelter will be reduced to an absolute minimum if it is covered by a large roof light, and we suggest that where possible you should have a flat concrete roof at least four inches thick, and devise other ways and means of lighting the staircase well, ways and means which lend themselves more readily to some sort of emergency protection, bricking up, or whatever it may be, in time of war.

In some types of buildings—hotels with their palm courts, for instance—which have just a glass roof over a very large area, an internal court of large dimensions of that kind constitutes a very serious source of danger, particularly in cases where the walls of the court are probably supported by unprotected stanchions. If you visualise a section through such a building, you will see that the conditions there may be regarded as very dangerous, because a bomb which found its way into such a courtyard—and these courtyards are usually large enough for a bomb to be able to do that—would have the most intense effects. While it may not always be practicable, it is suggested that if the exigencies of planning render it possible then instead of stanchions possibly widely spaced, or even solid columns, if you can contrive in your plan to put in a substantial brick wall, you will minimise the chances of the most serious form of demolition which you might experience in any building.

Pavement lights, and more particularly vaults under pavements, must be regarded as sources of very serious danger. Originally we thought they were perhaps dangerous because they might be damaged by falling masonry, and admit gas. As I have perhaps indicated to you this morning, I do not now look upon that as the most serious source of danger, but I do regard the large vault under the pavement as a potential source of danger for the same reason that I mentioned in the case of an open court in a hotel, namely, that a bomb bursting in it would do the maximum amount of damage to the building.

That brings me to the next point, that in association with pavement lights one sometimes finds stanchions at basement level which support the whole of the front wall of the building and its floors, and these stanchions are not too well protected with concrete, having only a bare minimum to satisfy the building regulations. In the same way one frequently sees a large span in the front of a tall building supported on 3-inch to 9-inch solid or hollow steel columns. This is likely to be a source of great danger. Even the fragments from a high explosive bomb would be capable in many cases of shearing through such a steel column sufficiently to make it useless as a supporting member, and would thus bring down the whole of the building above which it supports. I am not going to suggest for one moment that this particular form of construction is one to be abolished, but I do suggest that if vaults under the pavement and pavement lights are necessary, it may be worth while providing really good protection to the stanchions underneath, probably tying them back

in some way so that they are less liable to displacement by blast or other means. I am also not going to suggest that the shop-front as a display space should be spoiled by doing away with small section columns and stanchions and putting in large and solid brick piers, but I do suggest that it may be necessary for you as architects to devise for your clients, in the case both of new and of existing buildings, some sort of temporary shoring which could be put in position in time of emergency, so that if one of the supports is damaged or destroyed, there is something else left to hold the building up. Too many of the casualties in Spain have been caused, as I have already said, not by direct enemy action, but by indirect enemy action—that is to say, by the poor quality buildings with which they have been content. They have been caused, in other words, by demolition effects rather than directly by high explosive bombs.

The question of ventilation is one with which we shall have to deal to-morrow, but there are certain points which arise in connection with the general planning and construction of a building. One which I should like to mention again is that where the rooms are ventilated by means of fresh air inlets behind radiators, you should always try to use an arrangement which can be effectively closed in time of emergency. You nearly always do instal that particular type, but as a rule they do not work after a few years. It is in the case of rooms left hurriedly in time of emergency, however, that most gas casualties are likely to occur. I do not think that most of the casualties will occur at a time when people are on the alert, wearing gas masks or carrying them about, and in general expecting something to happen ; most of the casualties are likely to happen afterwards, when they have relaxed and think that everything is all right. That is why I suggest that this problem of gas protection is more serious in the general fitting and equipment of rooms than it is in the direction of gas-proofing some part of the accommodation used as protected rooms.

All the services in a building, such as gas, electricity, water, and so on, ought to be kept as far below ground as possible until they are well inside the building, and in the case of new buildings, they ought to be so located in relation to protected accommodation or shelter accommodation that if these services are damaged in any way they do not constitute a serious danger to the occupants of shelters. I am thinking, for example, of damage to gas mains and to water mains, and I am thinking, too, of internal services—steam pipes, etc.—which might be damaged through the effects of air attack, and, if near enough to shelter accommodation or the approaches to shelter accommodation, might cause a good deal of injury. The valves and controls of all these services should be, as I hope they usually are, placed in accessible positions, and they should be placed as near as practicable to the points of escape from the building or the points of approach to shelters, so that they can be readily turned off by people who may be going to shelters.

The meeting was then thrown open for questions.

Question : With regard to the effect of blast on windows, we have some peace-time experience of the effect of the blast of gun-fire on windows at fortified ports such as Gibraltar, where it is necessary to consider seriously the protection of buildings within the blast of the gun. I recollect that in certain buildings we had casement windows, and the order was given that when gun practice was to take place those casement windows were to be half-opened and a blanket placed under them' That blanket did not allow the window to close or to open fully, but it allowed it a certain amount of play. Breakages of glass due to blast were very largely reduced by that means. The question may be asked as to what will happen in the event of gas bombs being used in such a case, but there may well be circumstances when we may know that we have little to fear from gas, and then I think the casement window may prove to be superior to the sash window, which breaks just as easily when it is open as when it is closed. The same thing applies to internal glass partitions ; if there is an internal door and it is left half-open and wedged underneath with something which will allow it a little play, breakage is much less likely to occur.

Answer : I did suggest that windows should be opened in time of emergency when the warning of an air raid was received, taking the chance of their being broken by splinters. A sliding sash window, whether open or not, would almost certainly be broken, but when a casement window is opened both sides are being subjected more or less to the same pressure, and the chances of it being broken are reduced. You still have to face the gas risk, but I should be prepared to do that.

Question : In another colony I lived at one time quite close to a large gun which was frequently fired, and we simply opened the windows ; that was all we were told to do, and we never had any accidents. With sash windows, the sashes can be taken out without taking the frames out. With casement windows the difficulty could be overcome by opening the windows fully. Leaded lights would not be wholly immune from trouble, because if not broken they would be badly bulged, and it would cost as much to repair a leaded light window as to replace the glass in a window of an ordinary type.

Question : You suggest that a 4-inch concrete horizontal barrier would probably provide immunity against an incendiary bomb of 1 kg. I speak as one trained in chemistry, and who has seen thermite at work, and I understand that its temperature runs up to 1,500 deg. C. Ordinary concrete is usually made from some amount of cement, but with a very much larger proportion of sand and gravel. Both those materials are forms of silica, and silica undergoes a large increase in volume at a temperature of 575 deg. C. I should like to know whether, in your opinion, in the actual locality of the ignition of the thermite, the quartz does expand and fracture, and therefore let through the molten contents into the interior below. I have asked some friends who have seen some of this work, and they tell me that some kinds of concrete definitely do fracture under those conditions.

You say that you prefer framed construction to solid construction, and that refers mainly, I believe, to blast effect. The blast effect, as I understand it, is a very high compression wave striking a vertical surface, and it has a certain amount of energy which dissipates in a thousandth of a second. Energy

can be dissipated by mass multiplied by volume ; if you have a very large mass in the way, surely it is going to absorb energy without a great deal of deflection rather better than thin panels. I understand you condemned solid structure, but later you suggested that one-storey buildings with heavy roofs should be built with 12-inch concrete walls. If a 12-inch concrete wall is not a mass structure, I do not know what is. I am not satisfied that you have proved the case against mass construction.

Answer : I have seen a 1 kg. incendiary bomb ignited electrically on a concrete slab 4 inches thick, and the surface of the concrete was slightly damaged, but not so seriously that it could not be repaired. The reason for recommending a 4-inch reinforced concrete slab is that it is known by experiment to be capable of resisting the penetrative effects of an incendiary bomb plus the incendiary effects afterwards.

On the question of mass and blast pressure, I imagine that I have not made myself clear on one fundamental issue. I do not pretend, and I do not think that any of my colleagues on the Structural Precautions Committee would pretend, to have given you the precise answer to this problem. The recommendations which we are making are of necessity something of a compromise. We know, or we think we know, what architects have to do in the normal course of their business ; we know, or we think we know, something of the various and varying effects of high explosive bombs. We believe that a certain thickness of material is necessary to resist the penetration of splinters up to our standard, which requires about 12 inches of reinforced concrete, or 13½ inches of solid brickwork, which I think I can say are thicknesses by no means extravagant in building ; we would hardly call it a massive brick wall if it was 13½ inches thick. That is for protection against splinters. On the other hand, we have to consider the best ways and means of protecting buildings against blast pressure, which may come from the inside or from the outside. If it comes from the inside it is probably far more serious than if it comes from the outside, and we feel that if we have a building which consists of a box of thick concrete or stone or brick construction, that box will have the effect of tamping the explosion ; it will resist up to the last moment, and then it will fly, and if it flies and the walls collapse they will let down the whole of the superstructure. A framed structure ought to, and I am sure would, behave differently. The thin panel walls would resist the internal blast pressure only for a certain time and would then go, and they would go if constructed in accordance with our principles before transmitting to the structural framework sufficient stresses to damage that framework. That is why we consider that, so far as blast is concerned, a framed structure is less likely to collapse completely than a structure having solid load-bearing walls.

Question : In connection with framed buildings, can you compare for us the difference between a framed building with its framing on the outside and the cantilever type of construction, when the stanchions are set back 5 to 10 feet ?

Answer : That is certainly a new problem, and I find it, frankly, difficult to prescribe because we are not legislating against a single or precise factor of attack ; it may be blast that causes the damage, or it may be large splinters of high explosive shell or it may be a direct hit. Speaking generally, I should say that the damage by blast would be more or less the same in both types of building, except that where it is decided to set the stanchions back from the external wall, one assumes that the whole of this so-called external wall would consist almost entirely of glass or some other very light material, which would obviously yield very readily either to blast pressure from the outside of a building or to blast pressure from the inside, without transmitting any damaging stresses at all to the framework inside. One must assume that the stanchions that are set back are so constructed that they would not be readily destroyed by fragments from a high explosive bomb. If one could assume the rather sturdy reinforced concrete columns which are so frequently used with that particular type of construction, the probability is that although the columns might be damaged by fragments they would not be so seriously damaged as to bring about the collapse of the building.

Question : It has been stated by some local A.R.P. officials that all the gases released by bombs are heavier than air, and that consequently the most dangerous part of a building is the basement, and that we as architects ought to concentrate on making the upper storeys safe rather than the lower storeys. I take it from your remarks that you do not hold that view ?

Answer : Your assumption is correct. I incline to the view that although a gas attack might be very unpleasant, it is by no means the most serious contingency against which we have to guard. If a gas attack came alone one could probably go to the roof, but it will not come alone ; we shall in all probability have more high explosive than gas. I should be quite content with the protection against gas which my gas mask affords, and, having disposed of the gas problem, I would normally like to get below ground, where I can have better protection against high explosive.

Question : How would you recommend an architect to deal with the question of burst sewers and burst high pressure mains in a building, with an accumulation of water on the floors pouring down the staircase and into the basement, which cannot get away because the drainage system is broken ? How would you provide against that sort of thing in designing a building ?

Answer : I should hope to provide some sort of stopcock in a reasonably accessible position, so that I could turn off the high pressure main as soon as any damage was discovered. It is a serious danger, and the greater danger is damage to the high pressure mains outside the house. They are fully aware of that in the Whitehall district, where there are sub-basements below the level of all the drainage and large high-pressure water mains going down Whitehall. Damage to those mains would be outside the immediate control of the people in charge of the buildings, and very considerable damage might be caused before there was a chance to turn off the main somewhere in the street. So far as a building is concerned, however, the answer is to put all the control valves in the right position.

Question : Is it not possible, as an alternative to a 13-inch solid slab, to have a slab 4 inches thick and then a space and then a slab 9 inches thick, the 4-inch slab taking to some extent the shock ? I am referring to a floor slab.

Answer : The answer must again be vague, because we do not know what sort of bomb will hit the slab. Normally, a roof slab ought not to be designed to do more than resist the very smallest incendiary bomb which might be dropped in very large numbers. We do not know yet quite enough about the design of what may be called composite roof slabs to speak with any certainty of small roof slabs or thin roof slabs which are an economic proposition. I have already mentioned the type of roof which consists of a slab 3 feet thick, and then a 4-foot cushion of sand, and then another slab 5 feet thick on top, but that is out of the question in ordinary

building practice, and between such overhead cover and a 9-inch roof slab there is very little that is worth recommending, because a thick roof slab would only constitute overhead protection against a small projectile, a projectile small enough to be resisted by that slab ; the moment the projectile becomes large enough to break it up the overhead protection becomes at once an overhead menace, and you would probably have been far better off not to rely on a thick slab at roof level but rather on the cumulative resistance of a series of normal roof slabs, which should have the ultimate effect of retarding or diverting the bomb so that with luck it might burst in a position where it would do the least amount of damage.

Question : I think that we ought to have more definite information. A great deal of definite information must have been accumulated in the last war, and I venture to think that in other countries they have accumulated facts and could tell us definitely what would be the result of a bomb of 1, 2, 3, or 4 kg. falling on certain thicknesses of floor of a certain type.

Answer : I have told you that a 9-inch roof slab is considered to be sufficient to resist a 25-lb. incendiary bomb. A good deal of research has been done, and it was found that a 22-inch slab would resist a 25-lb. high explosive bomb. But what is the point in terms of practical architectural politics in saddling a large building with a 2-foot thick reinforced concrete slab, perhaps some 80 feet high in the air, when there is every reason to believe that the 25-lb. high explosive bomb will be the exception and not the rule ? Recent events in China and Spain suggest that at least the 250-lb. bomb, and probably the 500-lb. bomb, will be used in attacks on towns and factories. Further, what is the advantage in terms of practical politics in saddling a building with the responsibility of supporting a 2-foot thick slab of concrete 80 feet in the air when in very many cases there is just as much likelihood of the bomb coming into the side of the building and destroying the supports of that slab as there is of the bomb hitting the roof slab itself ?

I think it would have been possible, if it had been an agreed policy, to come here to-day and content ourselves with reciting for your edification or confusion the results of all the research which has ever been done. We might have told you how many feet of earth are necessary to afford complete protection against a 500-lb. bomb. As a matter of fact, it is about 80 feet, but when you know that, how much better off are you ? We could probably have given you a great mass of very confusing data, very little, if any, of which would have been the slightest use to you in your buildings. The mere mention of some of the figures would have frightened at least half of you away, and the survivors would take the figures back to their clients and frighten their clients away !

I hope that you will all bear with Mr. Bird and myself in realising some of the limitations which we are bound to accept and to put before you. We know how apparently little it all is, but, having considered the matter for two or three years, and having studied some of the results of these unfortunate wars abroad, we also know that the sort of precautions which we are recommending to you will, if the need arises, have the effect of cutting down casualties tremendously. We cannot guarantee security, but casualties can be reduced if you as architects will induce your clients to incorporate these structural precautions in the buildings which you have to undertake.

If that is our policy, what is the good of going away from here with a lot of high-falutin ideas, or even ideals, which nobody can afford to put into practice ? What I have just said sums up the attitude of the active members of the Structural Precautions Committee, and has been our guiding principle, that we would refuse to put our names to any report which was not reasonably acceptable to the profession we represented.

Question : You recommended the use of Durasteel for fire-proofing roof spaces. Would you also recommend the lime-whiting of the roof timbers above to stop the spread of fire ?

Answer : Durasteel is one of perhaps a number of suitable materials for laying on the floor of attic spaces. The lime-whiting of timbers does have the effect of retarding the incendiary effects of bombs. It is a very homely precaution, but it has more to commend it in many respects than some of the more elaborate methods for the so-called fire-proofing of timber.

Question : Nothing has yet been said about the density of concrete, yet the weight per cube of concrete depends enormously on the aggregate used, and you can put up a comparatively thick concrete giving first-class protection using an aggregate like pumice, or one of the high temperature slags, which will give extremely good protection, and yet not be anything like the weight of a floor of the same thickness with a denser mix. That enables you to have more protection with less weight and less risk if the stuff comes down.

Answer : I think it is possible, if sufficient research were carried out, that we might find that one type of aggregate was a little better than another. A certain amount of research has been carried out in connection with the use of the lighter aggregates to which reference has just been made, and the opinion expressed by the research department at Woolwich was that they were not much good. The real point at issue is that research would probably show there was very little in it, and in any case, if there was anything in it, that variation would exist only because of the stationary factor of the test to which all the specimens were submitted ; in actual practice, if these things were exposed to the effects of bombardment the factors would be different in almost every case.

Air raid precautions are in their infancy. If, as I believe, they have come to stay as a factor which will worry you as architects for some time, continuous research must be carried out to give you more enlightenment and to enable you to improve your methods, just as research has enabled improvements to be made in the use of iron and steel and concrete in architectural practice.

Question : Under the London Building Act, the pressure of the complete loading of a building when it is conveyed to the soil underneath is calculated according to the depth and the type of soil on which the foundations rest. The effect of blast on a building must have some influence on the total pressures on the earth. Has it been suggested that the London Building Act figures might be increased proportionately to provide a little more security, or is it thought that nothing could be gained by such a variation ?

Answer : That is an important problem which may have to be considered, but it is not regarded as vital at the present stage. One member of the Structural Precautions Committee, a very competent engineer, has given it consideration, and we have also received information as to the attitude of German engineers who are interested in air raid precautions on this matter ; and they both agree that the risk through earth impulse is not such as to make it seem necessary to make any change in existing practice.

Question : Have the effects of an incendiary bomb falling on an asphalt roof with a concrete sub-structure been observed ? I imagine that the thermite or other contents of the bomb

would be splashed all over the roof and on to any roof lights, and so on, situated thereon.

Answer : I do not think so ; I believe that the effects of incendiary bombs are normally very local. The evidence indicates that some foreign Powers have made from time to time types of incendiary bomb which have some kind of explosive charge, and which were believed to be capable of throwing out six or eight " pups," which went off some distance away from the parent bomb, but in the case of the standard type the effect is quite local.

Mr. BIRD : On the question of the burning of asphalt roofs, I have seen some French figures—I do not know what authority they have behind them—which state that ordinary natural rock asphalt will not burn under the action of thermite. I do not know how that relates to us, because many of the compositions sold as asphalt in this country contain coal tar products, which I imagine would burn readily. If there is any basis of fact in the French tests, the natural rock asphalt will not burn.

With regard to asphalt, I should have mentioned this morning that mustard gas has a natural affinity for asphalt, which it melts into a sort of poisonous paste, and it is exceedingly difficult to decontaminate because, naturally, the oily nature of the asphalt repels water. The problem is one of some seriousness when it is a question of decontaminating asphalt roads and flat roofs. The asphalt would probably have to be scraped off. The gas apparently softens it.

Question : Those who have attended courses on gas precautions have been told that if mustard gas in liquid form falls on any concrete or brick building it will remain there for months, and that the only method of getting rid of it is to demolish the building !

Answer : It is true that any absorbent material will absorb liquid mustard gas, but for the most part I think that those surfaces can be decontaminated. They remain slightly dangerous for some time, but we can have reasonable faith that those who are being instructed in the decontamination of buildings and streets will sooner or later be able to devise means of overcoming the difficulty. I certainly do not think that the danger is great enough for us at once to recommend the use only of non-absorbent materials ; that would undermine the whole structure of building practice.

Wing-Commander CAVE-BROWNE-CAVE (Member of the Structural Precautions Committee) : I agree that the more absorbent the surface the greater the difficulty of decontamination, but the consequence of incomplete decontamination is therefore less. The difficulty with asphalt and tar surfaces is that asphalt and tar definitely dissolve the mustard gas and make decontamination particularly difficult. Is not there a similar answer to the question of whether asphalt burns ? Asphalt in contact with ignited thermite unquestionably burns, but the question is, will the fire spread from that source of ignition, and that is the underlying problem in any fire question. That depends to a very large extent on the thickness of the material, and what it is in contact with, and similar points.

A great many members seem perplexed at the action of the explosion wave upon a heavy or a light partition. It is an effect which is so greatly different from what one normally encounters in engineering and architecture that it may be worth while saying a few words about the general problem.

When an explosion wave strikes a partition, a pressure is exerted on that partition for a very short time. It may be a very high pressure, but it is exerted for a very short time, and in consequence a certain definite dose of momentum is given to each square foot of the partition. The consequence of that is that you give to that surface an equal amount of momentum, that is, the product of the mass per square foot of the surface and the velocity which you give it. The mass multiplied by the velocity equals the dose of momentum. In any given conditions that is constant, so that you must look on your partition as having received a constant dose of momentum per square foot. The question of whether that partition fails or not depends upon whether it can absorb the amount of energy which results from that dose of momentum.

You have a distinction there between the momentum and the energy. If the partition is a heavy one with a large mass per square foot, the energy which results from a given quantity of momentum is small, and therefore there is a much greater probability that the partition can absorb that energy without failing. If you consider the amount of energy per cubic foot or lb. of the partition, you will find that the mass is more important still. Suppose the mass of that partition is M, and that receives a dose of momentum equal to the product of the pressure multiplied by the time, which you write as $\int pdt$, so that you can say $\int pdt = MV$. The question of whether the partition will fail or not depends upon whether the partition can absorb the amount of energy consequent upon that dose. The energy is $\frac{1}{2}MV^2$, which you can write in the form $\frac{1}{2M} M^2V^2$. M^2V^2 is a constant, and therefore you can say that the amount of energy which the partition will have to absorb is inversely proportional to its mass per square foot. That is why 21-ounce glass has such a bad time compared with a 9-inch brick wall ; it has to dissipate more energy per square foot than the brick wall does.

If you go a little further and ask what is the necessary resilience of the material, and how much energy has it to absorb per lb. for failure, you will find that the resilience of a light partition to be capable of resisting a given dose of energy has to be enormously greater than the resilience of a comparatively heavy one.

I think that the same general considerations apply to the problem which was raised of resistance to penetration. The speaker who referred to that matter asked what were the relative merits of one aggregate as against another, and I agree with Mr. Scott that it would be very difficult to say in general terms ; but the critical factor is how much energy the concrete will absorb before it fails. Suppose that instead of concrete you had indiarubber of the same mass, it would stretch to an enormous distance and absorb an enormous amount of energy, and therefore be extremely difficult to penetrate. Rubber will go to about a 600 per cent. extension, but concrete will go to an extension which I imagine is a good deal less than 1 per cent. If you can get some form of aggregate which will give you a large extension before failure, that will absorb the most energy and therefore be the best value so far as air raid precautions are concerned ; but whether it will be the best from the architectural point of view I am very doubtful.

The Conference adjourned at 4.40 p.m. until 10 a.m. the following day.

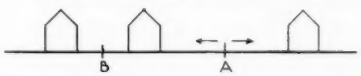
THIRD SESSION

WEDNESDAY, 15 JUNE 1938, AT 10 a.m.

PROTECTED ACCOMMODATION IN NEW BUILDINGS

Mr. T. E. SCOTT : I should like to begin by saying a few words about that very well-named aspect of structural precautions, blast. I have the impression that there is still a good deal of doubt in the minds of many members of the Conference as to exactly what this force amounts to and what can be done to make some provision against its worst effects. There have been many questions asked on the subject, and some members of the Conference have put forward views which may appear to be rather opposed to those which I have offered for consideration. I should therefore like to amplify the matter a little.

This blast pressure is something which may vary very considerably. It may be so slight as not to affect any part of the building except the windows, and it may be so serious as to destroy the whole building. We cannot control the exact way in which blast will have its effect on buildings ; all we can do is so to design and construct our buildings that they will give us the best chance of affording protection for individuals and that they will have a good chance of " staying put." That which may theoretically be the best solution may in practice be a solution from only one point of view, and may be a menace from another point of view. If a 500 lb. bomb fell in the centre of an open square, at *A*, if the square was wide enough it is conceivable that the blast pressure in the direction indicated by the arrows might not be enough to blow in 14-inch brick walls ; but if the same bomb fell in a narrow street, at



B, where the pressures are naturally confined or tamped, the chances of the blast pressure blowing in a similar wall are very much greater. Finally, if that same bomb should chance to fall into a building and burst inside the building, it is almost a certainty that the walls, however thick they may be, which attempt to resist the blast pressure will be blown to pieces.

We therefore contend that, taking all these possibilities into account, it is probably better to devise some form of construction which, in so far as blast pressure and the stability of buildings are concerned, regardless of personnel, stands a good chance of " staying put " in the main, but which goes in part. We have therefore said that a framed structure is probably the best, but one with wall panels which will yield almost immediately to blast pressure.

The wisdom of that recommendation is borne out in the one case we know of where a large bomb struck a framed structure, the case to which Mr. Bird referred yesterday, in which the framework remained largely intact. Part of the external wall went out, and a 13½-inch wall was pushed out lower down, and we are told by an observer that all that happened was that the upper part of the front wall was rebuilt quickly and the building was in occupation again in a very short time. If that external wall which was pushed out had been supporting roof slabs and floor slabs, the chances of the whole building collapsing would have been very great.

I now want to deal with what is in many ways the climax of my share in this Conference, and that is protected accommodation in new buildings ; because our chief concern will be the protection of individuals rather than the safety of our own buildings as buildings.

In the main, this shelter accommodation which we envisage in buildings is intended to comply with the standard to which we have already referred—to provide protection for individuals against splinters, to provide protection as far as may be practicable against the incidental effects of blast, such as flying fragments of glass, etc., to provide protection for the occupants of shelter accommodation against the effects of demolition (one of the most serious but fortunately one of the easiest things to do), to provide incidentally some protection against gas (not a difficult matter when shelter accommodation is being deliberately designed and constructed within a new building), and, of course, to provide protection against the effects of incendiary bombs, which normally is not difficult. With those limitations in mind, we will proceed to consider safety accommodation in buildings.

As a rule, it is only necessary to provide for the residents or workers, i.e., for the normal population of the building, but in many cases it may be essential to consider protected accommodation for a larger number of people, as in shops, where it will be necessary to consider the probable number of shoppers, presumably reduced in time of war. In other cases, and particularly, for example, in the design of blocks of flats and tenements in connection with slum clearance schemes, it may be necessary to provide adequate shelter accommodation not only for the occupants of the tenement building but for those who are still compelled to live in small buildings in neighbouring streets, small buildings which cannot be provided with protected accommodation and which, though presumably habitable, might be death-traps in time of war.

In many cases it will be found that, by working on the lines which Mr. Bird has already mentioned and will later amplify, it should not be difficult or unduly costly to provide this additional protected accom-

modation in a basement or semi-basement for a tenement building.

There is still a good deal of doubt in the official mind as to the size of shelter accommodation in buildings. There are two aspects of the question, with which I shall try to deal separately. There is first of all the aspect of concentration. For some years it has been a Home Office recommendation, and almost a regulation, that no shelter should provide for more than 50 people. The reason for that is obvious ; it is realised how difficult, if not impossible, it would be to provide complete protection against all possible forms of attack in any single shelter, and therefore it is best that people should be distributed as widely as possible, so that the number of casualties caused by any single bomb may be reduced to an absolute minimum. But, while the policy of distribution is undoubtedly a wise one from the national point of view—and also from a commercial point of view, because no manufacturer or business man wants to run the risk of having all his employees killed or injured—the working or residential population of any building is often such that it is quite impracticable to provide an independent shelter for each group of fifty people. All that I can do is to draw attention to this need for distribution and leave you to tackle the problems which come before you as occasion offers.

There is another aspect of this problem of the size and disposition of shelters, and that is ventilation. On this I will give you the whole story, because it is right that you should know something of the reasoning, even though your attitude will change, as the attitude of the Home Office is already changing.

One of the difficulties in providing protected accommodation is that of ventilating shelters which are rendered gas-tight. Mechanical ventilation may exist and probably does exist in many modern buildings, but unfortunately that part of the building which is probably most suited for use as an air raid shelter is usually not mechanically ventilated ; it is some part which is dark, because there are no windows, and presumably below ground, and the chances are probably against its having any form of mechanical ventilation. You may have to envisage, therefore, either providing a special form of ventilation or shutting up a large number of people in a sort of " black hole of Calcutta " for what may be a comparatively long period—the period which at one time was envisaged by the Government was five or six hours.

If a shelter is mechanically ventilated, accommodation ought to be provided on the basis of 6 square feet of floor area per person, and an air space of about 35 cubic feet as a minimum. Gas-tight shelters without mechanical ventilation might be satisfactory for reasonable periods of occupation provided that they have a large area of wall surface which is capable of absorbing the moisture of respiration. Mr. Bird has referred to the proved fact that a shelter having walls capable of absorbing moisture can be occupied comfortably for a longer period than a similar shelter having non-absorbent walls. In such cases, the figures considered applicable were that not less than 75 square feet of wall and ceiling surface should be available for each individual, which indicates that a much more generous allowance of floor space is necessary for each individual, according to the height and width of the shelter accommodation.

But, having given you those figures, let me tell you that the Home Office appears to be slowly coming to the view that this problem of providing protected accommodation, certainly in existing buildings, ought to be looked upon as a twofold problem. In the first place, it is desirable to provide any sort of " better 'ole " to which people can go while the heavy stuff is falling. The accommodation may be such that human beings could not be expected to remain in occupation for a long period, but at least they could stay there for some minutes, and perhaps half an hour, while a raid was actually in progress, and be protected against the more direct effects of a raid with high explosive bombs. They might even be protected against gas, but even if they were not they would have their gas masks. That is the first provision. It is better that people should be packed fairly closely and safe than that they should have a generous floor area and be open to direct attack by high explosive bombs the whole time.

If in a building you can provide that " better 'ole," you may be able to have in addition some part of the building to which people can go afterwards if there is gas about, and where the accommodation will be on more generous lines, possibly on an upper floor, and which can be made reasonably gas-tight and also may be ventilated mechanically, and where staff can carry on with their work if necessary, even though there may be a certain amount of gas about outside.

I mention that aspect of the problem to you because, when you attempt to apply these principles to your problems, you will very often find that you cannot achieve the ideal. You can provide some sort of accommodation where people will be reasonably safe against high explosive bombs, but you may not be able to provide that accommodation on such generous lines as have hitherto been laid down by the Home Office. I therefore submit that it is better to pack your people up and make them safe for the short time when bombs are dropping, and then let them go out immediately afterwards and hope for the best against gas, which is not nearly such a serious danger as are high explosive bombs. That is the point of view towards which the Home Office is slowly but surely moving, despite any recommendations which may have appeared in the Press and elsewhere.

With regard to the location of shelter accommodation, as a general rule it is best provided in the basement, where lateral protection against splinters is

automatically obtained ; but in special cases it may be necessary to avoid providing the accommodation there where there are additional dangers from damaged sewers or water-mains or similar risks. That will not apply in the majority of cases, but it is a very serious problem, for example, in the Government buildings in Whitehall, where the mains and sewers are at a considerably higher level than the basements.

Even where there is a sub-basement it is probably better to put the shelter accommodation in the basement, i.e., one floor below ground level, because then it will usually be easier to provide and maintain adequate approaches to and exits from that accommodation. In ordinary circumstances a sub-basement cannot be occupied by a large number of people, because the exigencies of planning will not usually demand a large number of staircases. You do not want to make your air raid precautions more costly than they need be, and therefore as a rule it will be better to put the protected accommodation in the first basement, even though there may be a sub-basement.

I have already referred to the vulnerability of pavement lights and vaults under the pavement. Where these are essential to the design of buildings it may still be best to put the protected accommodation in a basement, with suitably constructed protective walls around the actual shelter accommodation.

The ground floor may in some cases be suitable for shelter accommodation ; in fact, where there is no basement you will probably think automatically of the ground floor as the best place. Notwithstanding any recommendations which have hitherto appeared regarding the occupation of upper floors, I still think that from a psychological point of view people will want to get as near to the ground as they can. There is at least this to be said for it, that from a shelter at ground floor level it is usually easier to provide really adequate means of escape than it is from a shelter on an upper floor.

It will be quite obvious to every architect that in placing the protected accommodation on the ground floor it may be necessary to watch for all kinds of snags. In stores and shop buildings, where some if not all of the external walls are simply stanchions and glass and not walls at all, very little protection is automatically provided for people sheltering at that floor level. The exigencies of the plan may make it possible, however, somewhere inside the building to construct thicker walls—13½ inch is the standard—and to form within them adequate shelter accommodation. If you bear the principle in mind, it does not call for any great ingenuity of planning to provide what is required.

Shelter accommodation, however, may have to be provided on an upper floor if a suitable place is not available elsewhere. I would remind you again of the argument in favour of that, namely, that it may not be so vulnerable to gas attack ; it is subject, however, to very serious disadvantages. The first is the natural tendency to seek refuge below or near ground level, and secondly the cost of providing thick walls to give a certain amount of lateral protection and a demolition slab to support the upper part of the building will usually be very much greater if they have to be provided up in the air and be supported than if they are provided near ground level, where the cost of holding them up is not nearly so great.

Shelters should not normally be located near to enclosed courts or light wells. If the external walls of a shelter are the external walls of the building, as they may have to be in some cases, I would where possible in planning the building put the shelter against the widest space surrounding the building.

The occupants of buildings the contents of which involve abnormal fire risks ought always, I think, to be provided with external shelter accommodation. Shelter accommodation should not be provided in or near heating chambers or engine rooms, owing to the risk of damage from broken steam or gas or water pipes and other power services, and owing to the incidental risk of gas being drawn into that part of the building because of the draught of the flues from the furnace.

It is, I think, at once obvious that if the peace-time use of the accommodation which you design as an A.R.P. shelter does not involve the provision of large windows, you would be wise to avoid putting in large windows just for the sake of putting them in. Keep the windows as small as possible, and then if there should be time to fill them up the labour involved is not great, and if they are not filled up they do not represent such a serious source of danger from splinters as do large windows.

The next point is probably one of the most important, and it is that protected accommodation must have really adequate alternative means of access and escape. The period of warning which may be expected in many cities of England may be as short as five minutes, and for London I believe that seven minutes is regarded as a likely period. In the case of buildings where every effort will be made to keep people at their jobs as long as possible, it will not be easy in a period of seven or even ten minutes to stop the machinery, turn off power supplies and do the other things that are necessary and then find one's way into the protected accommodation. It is therefore important, I think, that the means of access to shelter accommodation should always be properly proportioned to the number of people who may be expected to occupy that accommodation. Mr. Bird has referred to the L.C.C. regulations for exits from places of amusement, and they seem to indicate an apparently generous but reasonable standard upon which to base calculations. In very small shelters such as you will have to provide in some buildings the sort of manhole cover type of emergency escape is all very well, but it is not the sort of thing to provide

for a shelter which may have to hold 250 people ; I should not like to imagine 250 people trying to get out of a little manhole in a hurry !

I do not think that I need deal with the recommendations of the Home Office with regard to providing gas-locks at the entrance to shelters. A gas-lock is in principle a double door, consisting in many cases of a blanket, so that the actual entrance to the shelter is not open immediately to the outside air and people passing into the shelter have to come through two sets of doors into a lobby. Whether those doors take the form of a blanket or not you will have to decide ; the advantage of a blanket or some similar type of covering to the opening is, of course, that it would not be so easily damaged by blast, even at a distance, as an ordinary door. An ordinary door might be blown off its hinges, but a blanket might just flap about a little and could then be put back into position again. In any case, the provision of a blanket as part of your design of a building is rather beside the point. All that you will do if you are wise is to give some thought to the placing of lobbies at the various entrances to your shelter accommodation and leave it at that, though you may perhaps induce your clients to have made a suitable frame and very light door or blanket which could be put in position at a moment's notice if the need should arise.

Splinter-proof doors are now coming on the market for use in connection with shelters, and you will probably see more of them in the near future. Things of that kind are all very well where a shelter is being provided as a public refuge and is not going to be used for anything else, but we are now thinking in terms of buildings for ordinary peace-time purposes part of which would be serviceable in time of war, and I think we shall find that most of the so-called splinter-proof doors would be quite unsuitable for any ordinary peace-time use. But it may be possible in many buildings, and it may also be desirable, to get your clients to obtain such a door and make reasonable provision for fixing it in position if and when the need should arise. If the need should arise and you have not done anything about it it will probably be too late, and the only thing to do is to be ready for any emergency.

With regard to the construction of shelter accommodation, where possible it will be an obvious advantage to use as shelter accommodation rooms which do not need a great deal of natural light. One reads a good deal about the filling up of windows with sandbags, but I do not think that that is really a practicable proposition in the majority of cases. It may be necessary in connection with existing buildings, but it is not the sort of thing which could be undertaken by the community as a whole, and in very many districts it would be almost impossible to find the material to fill 500 sandbags, let alone the 80 or 90 million which I believe the Government have ready for somebody to fill. It would be quite impossible, for example, to fill the windows of the R.I.B.A. building in order to provide protected accommodation. A sandbag wall ought to be two to three feet thick, and that means a tremendous task. I would therefore urge all of you who are concerned with new buildings to leave sandbags out of your reckoning altogether, leaving them to those who have to provide protection for existing buildings. Do not provide for the use of sandbags in any building which you are about to design.

The walls actually surrounding the protected accommodation ought to be of the thicknesses referred to in the table which Mr. Bird has given—13½ inches of solid brickwork, 15 inches of mass concrete or 12 inches of ordinary reinforced concrete. That protection ought also to be applied to the corridors and staircases which lead to this protected accommodation. That is very important. It is no use providing a good shelter in the middle of a large building unless you have equally well protected corridors and staircases leading to that accommodation ; otherwise, of course, the shelter might just be a death-trap.

Immediately over the shelter accommodation you should provide a demolition slab designed to take the loads which I quoted to you yesterday. That slab would probably have to be fairly thick, and might be at least 8 or 9 inches thick, according to the span of the shelter accommodation. Speaking generally, if a large building needs a very large shelter it is probably better to divide the shelter up with cross walls so as to reduce the span of the demolition floor slab ; in terms of cost that may not represent very much. This incidentally will make it very much easier to organise the people who may have to occupy these apartments and reduce the risk of panic.

One small practical recommendation is that in order to reduce the risk of injuries caused by plaster which might be shaken off the ceilings, it might be an advantage to line the ceilings with some sort of fibre board which can be put on the shuttering before the concrete is poured. If a suitable board is chosen, it may also help conditions in an unventilated shelter by absorbing moisture.

With regard to ventilation, I have mentioned mechanical ventilation and air-tight shelters which are not ventilated. The real point is that during actual occupation in a time of emergency the shelter ought either to be sealed against the outside air and mechanically ventilated or be capable of being instantly sealed. So long as a shelter which is not mechanically ventilated is protected against splinters, it may not be unduly dangerous to leave certain window or door openings open, because gas, if gas should be dropped, does not act quite as quickly as high explosive. The bursting of a high explosive shell is all over before you know that it has arrived, but gas has to spread itself a little, and it is not unreasonable to assume that somebody would be able to give warning of poison gas in time to

enable people to seal up or shut the doors and small windows of shelter accommodation. I make that suggestion for what it is worth and for consideration in connection with these very small "funk holes," as we might have to call them, where they represent the only possible accommodation in a building which will afford protection against splinters and into which it may be necessary to herd a large number of people who could not stand it for more than a quarter of an hour if all the windows were shut and there was no form of mechanical ventilation. I believe that the German attitude is that they would leave all the doors of shelters open until gas was detected and then they would shut them quickly and keep them shut as long as necessary, and then open them again and try to get some fresh air into the shelter.

If the shelter with which you are concerned is a large one, and you are able to consider the advantages of mechanical ventilation, then I hope you will be wise enough to go to a specialist. Some form of mechanical ventilation is, of course, essential in protected accommodation which may have to be occupied during hostilities. In police stations, post offices, control points in industrial concerns, etc., things cannot be left to take care of themselves, and it may be that a nucleus staff will have to go on working indefinitely in the safest possible conditions which can be created for them, and then some sort of ventilating plant will probably be necessary. If it is, it would probably be unwise to rely upon an outside source of power supply, because in many cases it is reasonable to assume that these supplies would be cut off as soon as an air raid warning was received. That is not an official prediction, but I think that it is a reasonable probability, and it is generally recommended that any mechanical scheme of ventilation should be driven either by some form of petrol engine housed, of course, outside the shelter or by some manual means, possibly a kind of tandem bicycle. The Germans have a very efficient manual method operated by hand which one person can work, and which provides adequate ventilation for a reasonably large shelter.

I shall not go into the problem of ventilation in any detail, because it is obviously work for a specialist; but I would remind you that the Home Office have already issued a standard specification for a gas filter. It would not be good enough to go on with an ordinary ventilating plant, drawing air in and pushing it through the rooms, because if there was any gas about it would be drawn into the shelter, possibly with very serious consequences. I believe that the provision of a filter which will keep out all known poison gases is not difficult.

One important point is that if in any of your buildings you have an ordinary extract system of ventilation it ought to be shut down at once if there is a warning of the possibility of an air raid. Such a system of ventilation would be a source of tremendous danger if there was any gas about.

So far as lighting is concerned, you have to face the probability that the public supply will be cut off, and it seems desirable to provide in important cases for some auxiliary system of lighting. This is essential, of course, where the occupants of a shelter have duties to perform during a raid. Whatever is provided, whether a generating set or storage batteries, ought to be provided in a lobby outside the shelter itself but accessible from the gas-lock. There is no recommendation about other forms of lighting, except that any which consume oxygen ought for obvious reasons not to be installed inside the shelter; i.e., candles, oil lamps and the like. But, though it has not been tried or officially recommended, it might be practicable to insert wired glass properly sealed in a recess in the thickness of the wall of the shelter, behind which any form of oil lamp or other illumination could be placed, drawing its air supply from outside. That is the sort of thing which will no doubt occur to all of you as quite practicable, particularly where an expensive auxiliary system of lighting or storage batteries is out of the question on economic grounds.

With regard to equipment, this is not the time or the place to refer to the wireless sets and other things that the Home Office have recommended for inclusion in shelters. They are all so obvious that I am not going to waste your time on them, except to remind you that when you are planning shelter accommodation on generous lines in an important building you must consider the provision of sanitary accommodation. In some cases it may be possible to plan something on permanent lines which may be used in time of emergency, but if that is not practicable you may have to plan your shelter so that a small compartment can be set aside to receive one or more dry or chemical closets in time of emergency. You ought also to provide for a cold water supply in or near the shelter accommodation for drinking purposes, and if any provision is made for the storage of food it ought obviously to be in canisters or cupboards which can be made air-tight.

Most of those recommendations can apply in the main only to large buildings. At the other end of the scale we have the small buildings to which it may be quite impossible to apply these recommendations exactly as they are given to you. A small building will not have the same number of floors, it will not as a rule have walls of the same thickness, and in short the constructional requirements of a small building are not likely incidentally to give you the same degree of protection as in the case of a large building, because with a large building, as we have already said, quite apart from that protection which we deliberately plan in providing protected accommodation the very nature of the building and its construction will, as a rule, afford much greater protection than we anticipate. But in

every small building, whether it is a four- or five-room cottage or a small terrace shop such as we see in the suburbs or whatever kind of building it happens to be, it ought always to be possible to provide one room which is suitably constructed and planned for use in time of emergency. It cannot as a rule conform to the standards of size which have been laid down by the Home Office, and it may not always be possible to provide a demolition floor slab of the thickness and strength which I have suggested; but, however small that "better 'ole" may be, it can still, I think, have walls thick enough to keep out splinters, it can still have some sort of reinforced concrete ceiling over it which ought to resist all but the most serious effects of demolition and thus it ought to provide the occupants of the building with somewhere to go in time of emergency.

I mention that aspect of small buildings because I should not like anyone to go away feeling that just because he cannot do some of the things which have been recommended it is not worth while doing anything. The real purpose of this Conference, so far as I am concerned, is that I want you to have your eyes open to the possibilities and fundamental requirements of air raid precautions in buildings; because all of you, when you approach your individual problems, will be far more qualified than I am to find the right solution, and in any case, as I said yesterday, this subject of air raid precautions in buildings is in its infancy. We shall progress as more research is undertaken and as we have more opportunity of studying our own particular problems in order to apply these principles to them.

PROTECTED ACCOMMODATION IN EXISTING BUILDINGS

Mr. E. L. BIRD: Protected accommodation in existing buildings in effect usually means the preparation of a complete A.R.P. scheme for an existing building on behalf of a particular client. It envisages something more than merely finding accommodation for the occupants of the building. I am thinking now of commercial and industrial firms who in employing an architect may say "We do not know anything about A.R.P.; what can we do?" The architect will have to consider incendiary bombs and gas and the keeping of the business running in time of war as a second line to the provision of shelter, at any rate in a very large number of cases.

In doing that, you should consider that your recommendations will automatically fall under two heads: (1) those to be done more or less immediately, in peacetime, and (2) those which can be done on the outbreak of war. Anything which involves the obtaining of materials or much labour will be impracticable on the outbreak of war. There are certain things like strutting and sandbagging which might be done. Where there is a large pool of male labour and a certain amount of free land, for example in the case of a factory, it may be worth while obtaining sandbags in peacetime, and if necessary a couple of days labour can be put on to filling them. In a large number of cases with existing buildings, however, that would be quite impracticable.

Another thing which you have to decide straight away is whether you are going to shelter the inhabitants inside the building or outside. We have had a great deal of information recently about the value of trench shelters, and the value of the widely traversed roofed-over trench shelters in Barcelona has been referred to. I think there is no doubt that a trench shelter in the open, roofed over if possible, will give better results than herding people together in shaky buildings or buildings which give poor general security.

What are the general considerations to study in considering an existing building? First of all, does it conform in general terms to the principles for new buildings which Mr. Scott has suggested? You have also to examine the building in detail; it is not possible to generalise, and I suggest that this is very much an architect's problem, because he must study and understand the construction and what it implies; he has also to understand the use of the building. In passing, I would suggest to architects the importance from the national point of view of their taking this up, because alternatively who is to do it? The A.R.P. officers serve the population as a whole, but who is to do it for the individual large property owner or commercial firm? Either they must employ a consultant of some sort, preferably an architect, or they will go to a commercial firm; and it is in the public interest that we should prevent this business falling entirely into the hands of commercial concerns some of whom might possibly be inefficient or even unscrupulous.

The points to consider are these: (1) Is it near a military target? That is important, and not much has been said about it. The worst case is probably that of the man who lives immediately outside a naval dockyard, while the best case is that of the man who lives in a remote part of the Highlands. The difficulty is to determine the degree of risk in between, but that should not be too difficult if you know the district with which you are dealing. You have to consider the proximity of military establishments, by which I do not mean the local Territorial headquarters which will not be an easily distinguishable target, but large military establishments. Then there are railways, dockyards, munition works and large works capable of being turned into munition works, such as the large motor-car factories and many other cases which will suggest themselves to you. There is also the fact that the town centre is a much more vulnerable target than the outer

suburb from the point of view of " panic bombing "—not destructive military bombing, but bombing directed intentionally against the civil population.

(2) Low fire resistance or abnormal fire risk. It is little use saying that a building is of fire-resisting construction if it is next door to a celluloid factory !

(3) Doubtful lateral strength, and incapable of improvement in that respect.

(4) Wholly or almost entirely of timber construction, which increases the incendiary bomb risk.

(5) The amount of window space in the building. I am thinking of buildings with large windows and without a basement, or with poor possibilities of refuge accommodation.

(6) Whether it has large projecting architectural features—cornices, pediments, unsupported gables, towers and high chimneys.

(7) Safes and machinery on upper floors.

(8) Courts and light wells.

(9) The risk of flooding.

All those are points which you ought to bear in mind in considering an A.R.P. scheme for an existing building.

In the selection of shelter accommodation, the points to consider are :—

(1) Gas-proofing possibilities and measures.

(2) Splinter protection.

(3) Small incendiary bombs.

(4) Demolition.

(5) Windows blown in.

(6) Means of escape.

With regard to the location of shelter accommodation, quite obviously, as we have said before, below the ground is best if possible. It will be determined primarily by the degree of protection which you can obtain. You have to consider how far it is worth while adapting by strutting, etc., existing accommodation, and you may find that you have several alternatives. As I said at the inaugural meeting, the chief difficulty is assessing relative risks, but you may find less difficulty having heard the previous lectures than you would otherwise. I would point out in this connection that what Mr. Scott calls the " birdcage " type of construction, though admirable for resisting the effects of incendiary bombs and for remaining unaffected by the effects of high explosive bombs, affords the very poorest protection if there is no basement, and that indeed forms one of the greatest difficulties in the big office building. There was submitted to the Committee not long ago the drawings of a big office building, and we could suggest almost nothing for that building, which contained 800 to 1,000 people, except some adaptation of the staircases and/or the building in the very open basement of shelter walls—the creation of actual shelters in the building. It was a multi-floor building. The ground floor was of glass, with shops on both sides. There was a stallboard light to the basement and pavement lights, and the basement was 240 by 60 feet and practically open. That is an example of a really difficult case.

In many cases the ground floor will not be strong enough to support the debris of the superstructure in the case of a basement shelter. The obvious thing to do is to increase its strength if possible, either by strutting as a temporary measure or by persuading the client to substitute a thicker floor which may be built immediately underneath or instead of the existing floor. In the case of a shop this might mean such a dislocation of business that probably the owner would not agree. So far as strutting is concerned I have here some notes on the subject applicable for wooden floors. They will be published as an appendix* to the report of these proceedings, and can be obtained also from the A.R.P. Department of the Home Office. The tables of strutting for floors other than the domestic type wooden joisted floors are not yet finished but will be available in the near future.

Now let us consider structural measures for a few moments. You have to consider whether they should be temporary or permanent. There is the question of the use of sandbag walls inside basements with pavement lights, and the possibility that if you do not build such walls in permanent materials you may be able, if you can get (*a*) labour, (*b*) sand and (*c*) sandbags to provide sandbag walls inside. For the building of new shelters inside basements precast concrete units can now be obtained from certain firms, and will reduce the mess and nuisance of working inside an existing basement. There is also a type of sheet steel arch construction, rather like the old wartime Nissen hut, which has been developed for mining work instead of the ordinary timber strutting for mines, and which is known as Locksheet. There is the possibility of erecting this inside a basement against an inner wall surrounded with mass concrete or brickwork and concrete. That can be erected fairly easily as a shelter inside an existing building.

Where the windows are small and the walls are thick you may, of course, put your shelter on the ground floor if nothing else is available, but then you will want something to close the window openings as much as possible and you will perhaps require strutting of the floor above. Another point to remember is the bearing of your strutting. If you decide that you cannot use the basement, and therefore decide to use the ground floor, the strutting has to be taken down to a firm foundation in the basement. It is worth while considering the use of tubular steel scaffolding for this. It is easily erected, particularly if designed and cut beforehand, and is, of course, much easier to handle than large baulks of timber such as 8 × 8 and 8 × 6, which are distinctly heavy.

With regard to the possible use of upper floors, the use of central corridors is something to consider,

* See Appendix page 832.

especially where there are double stanchions, one on each side of the corridor, in a framed building. The projecting floors on either side will tend to give protection against the upward strike of splinters. You may find a room on an upper floor which at first sight appears admirable for your purpose, but which proves not necessarily to be so. I found in this building a windowless storeroom on an upper floor which I thought admirable until I realised that the room underneath it had very large windows coming right down to the floor, and there was only a thin floor in between, so that a considerable area of the room, though it had an 18-inch brick and Portland stone wall, was vulnerable to the upward strike of splinters through the thin hollow-tile floor.

If you use rooms, select those facing open spaces. In an 80-foot building—the full London Building Act height—I suggest that the second or third of the eight or nine floors is best. There is a good deal to crumple up above you, and you are high enough up to be less open to blast and splinter effects.

A few general points. Permanent construction is obviously best if you can persuade your clients to do it. An important thing so far as incendiary bombs are concerned is the clearing of attics and the fire protection of timbers with whitewash or alum solution or some similar material. In long open roof spaces such as are found, particularly in modern rows of terrace houses, where the practice of carrying the party wall up has been abandoned, or in any long roof, I suggest that you should consider the use of expanded metal screens with gypsum plaster. Gypsum is a strongly fire-resistant material, particularly when it is reinforced against cracking by expanded metal. I do not suggest that such a construction would have a very high degree of fire resistance, but it is likely to stand up reasonably well for a considerable time and at any rate prevent to some extent the spread of fire.

Mr. Scott has already mentioned the question of the lodgment of bombs on the ceiling joists. There are various ways of dealing with bad cases. If the joists will stand it—and also if the finance will stand it !—a light concrete slab will be useful, and it may be possible to use precast slabs. Such precast slabs may be of one of the porous aggregates, because you are dealing with a case in which the lightest incendiary bomb has been retarded by the roof and is more or less resting on the slab. If you do not want to put too much weight on the roof you can use foamed slag or light aggregate either in situ or slab, and you can also use Durasteel or similar materials. There is also the question of using sand. It is worth while noting that hitherto in this country the recommendation has been 2 inches of sand. I understand that the Germans recommend 9 inches of sand, though where they find ceiling joists that will carry a 9-inch load of sand in most houses I do not know.

Another point to consider is the protection of lantern lights. That is exceedingly difficult where the lantern lights are at all large. The most vulnerable point in the R.I.B.A. building is the lantern light over the main switchgear for the electric heating. Obviously the glass will be broken, and we have to keep the weather out and keep out shrapnel and "bits" generally, so that what I have suggested is that we should make a timber framing and have it ready to put up on the outbreak of war ; this would be covered with boarding and covered with a building paper which will keep the rain out temporarily. That is a first measure. Secondly, it is proposed to put some sandbags over the top of it, and the sandbags and the sand are to be bought for this purpose ; fortunately we have dry vaults in which the sand can be stored, for otherwise there would be no possibility in this building of obtaining any.

The last point is obviously the protection of free-standing stanchions and columns. A particularly dangerous type is the old domestic building which has been turned into a shop, of which there are hundreds in every town ; in these the ground floor wall has been taken out and a girder or in some cases even a wooden bressummer put in to carry the upper structure, possibly on a couple of cast-iron columns. Obviously such a construction is weak, and it is worth while considering the protection of those columns in some way, particularly, of course, as the rigidity of the connections is not by any means what is obtained in a proper steel-framed building.

I should like to say something about small houses. Here again it is a question of relative risks. The outer suburbs with twelve houses to the acre are not in any immediate danger except from the man who misses his target or who is being chased and wants to get rid of his cargo of bombs. I do not think that any sane air force would spend its time bombing outer suburbs when it has so much better targets presented to it ; it will only bomb those outer suburbs by accident, as it were, if in some way it is prevented from reaching its better targets.

When you think of the ordinary post-War house, with its 11-inch cavity walls, its 9 × 2 and 7 × 2 joists, its light roof unboarded in a number of cases, its absence of basement, there is only one answer, and that is to have a covered trench in the garden. I am not, however, laying down any hard and fast rules, because each group and class of buildings and each area must be considered by itself. It is so easy to generalise, but I think so dangerous. With regard to terrace houses, the basement can be used where it exists, and where it does not, a choice has to be made between using the back garden and sheltering in the house itself. A good deal depends on the size of the back garden. A semi-basement is better than no basement at all. The non-basement terrace house is probably the worst of all from the point of view of the provision of shelter accommoda-

tion, particularly in the case of old property, which is probably rather shaky. I have not much to offer you there, and it is probably a matter for the local authority to consider the question of public shelters. It is one of the worst problems there is, but it hardly comes within the purview of this Conference.

The meeting was then thrown open for questions.

Question : In the last war a good deal of damage was done by fragments of anti-aircraft shell. The outer suburbs may not be attacked by bombing, but they may suffer a good deal of damage from the fragments coming down.

Answer : Yes. I suggest that it is important to cover trench shelters in the outer suburbs. There will be no protection in the building itself; a piece of shrapnel coming down from 20,000 feet will go right through the ordinary suburban house. The obvious answer seems to be to put something over a trench shelter, such as sheets of corrugated iron with earth on top; you can build the rockery there!

Question : Do you consider that the occupants of ordinary houses should dig trenches in their gardens if they are in a vulnerable area, for instance if they occupy three-storey Victorian houses?

Answer : That is a matter for the occupier to decide, taking account of his relative risk. In what seems a risky position it may be worth doing.

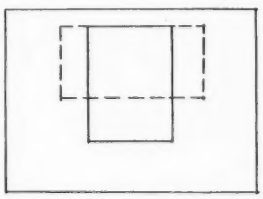
Question : For the protection of attics I gather you suggest, in addition to the sand or foamed slag, the painting of the timbers?

Answer : Yes. I mentioned alum solution, which is used in theatres to make scenery fire-resisting, and whitewash, and there are several proprietary materials some of which, I believe, give very good results. Whether to spend a good deal of money painting timbers in attics with expensive fire-inhibiting paints is a matter of personal choice.

Question : In the case of an office building or a building containing instruments which must be used or work which must be carried on, is it recommended to raise the sill and partly block up the windows to give better protection to the staff?

Answer : I agree with that, and obviously where you have valuable machinery, if you can prevent splinters hitting it, it is an advantage, because the machinery cannot take shelter and human beings can. The raising of the window-sill only one or two feet may do a good deal; it will obviously make a considerable difference to the angle at which splinters will come into a room.

Mr. SCOTT: That is also applicable to new buildings. In the design of any new buildings, the type of window which would normally be put in is as shown in the diagram, and that is probably adequate for all ordinary purposes; but if there is freedom as to the shape and position of the window, it may be better to put in a window of the type shown by the dotted line. If an adequate area of window can be provided high up, the protection afforded by the wall itself to the machinery, instruments, etc., inside the room will be very much greater. That is an obvious and elementary principle of design where you have freedom in regard to the shape of windows, and where it is impossible—as I think it will be impossible in many cases—to devise sandbag protection or steel shuttering or anything else for the windows. With a window of the type suggested and a high sill level, a room will automatically have protection against splinters at any rate, and that is a point in design which I suggest you should consider.



Question : Has any scheme for a shelter for the rather vulnerable R.I.B.A. building been prepared?

Answer : We have a staff of about 55 here in a very large building, and we have a considerable amount of good shelter accommodation below ground level. The boiler-house, which is very well below ground level, cannot be used for a number of reasons, particularly because although an electric boiler-house has no flues, it has a great many pipes and water tanks and the escape from it is poor. I have recommended the Council to divide up the occupants into three groups, so as to split our risks. We have an excellent basement strong room which will contain about a third of the staff, and that has been earmarked for the female staff. We have some quite good shelter accommodation at the back end of the building in a series of superimposed internal windowless store rooms which have the outer wall some way away round them. Then there is another room at the front on an upper storey where I propose to put a small number of people and the fire-fighting squad to watch for the fall of incendiary bombs. The question of the ventilation of the strong room has been thought of; we have great numbers of books there which add considerably to the absorbent area.

Question : In the protection of such places as sub-stations and transformer stations, would not better protection be obtained by sandbagging?

Answer : It all depends on the labour and materials. A good sandbag wall at least 3 feet thick affords admirable protection. Gravel is equally good.

Question : Should sandbags be spaced some distance in front of the face of an existing building?

Answer : No, it is better for them to be up against the building, and the sandbag wall then obtains some additional strength against blast.

Question : You have referred to the use of gravel in sandbags. Is not there a grave danger of the gravel becoming missiles in the event of an explosion?

Answer : In the event of a direct hit on the sandbag wall, yes, but gravel is excellent for providing protection against splinters.

Question : In many districts round London we have a great deal of chalk. May not chalk be better than gravel?

Answer: Chalk would be very suitable.

Question : Reference has been made to the advisability of leaving windows open in shelters. Have the Committee had a physiologist to inform them of the effect of a concussion wave on the lungs of people inside the building? I believe that at a range up to 20 or 30 feet the concussion is sufficient to flatten people's lungs and asphyxiate them, and it seems to me that that is one of the objections to the open window. If the explosion takes place in the proximity of the shelter the building may stand up to the blast effect, but the human beings inside may not be able to do so.

Mr. BIRD: You mean that if the glass breaks it will tend to check the wave?

The Questioner : I suggest it might. I speak from experience during the war of being near heavy guns when they were firing, and anyone who has been in that position will

remember the push on the chest and the gasping afterwards. I submit that if you have a real compression wave hitting you in the chest it will deflate your lungs and you will not be able to inflate them again.

Reference has also been made to terrace construction. With terrace construction of the older type in particular, with 13½-inch outside walls and properly built party walls, it should be possible to convert the central portion into one of the towers which have been advocated for larger framed buildings. The inhabitants could get together and call in an architect and pool their money in order to turn the central portion into an air raid shelter with a strong roof on the top, and if necessary the party walls could be strengthened.

Answer: On the question of blast effects on human beings, I understand that the A.R.P. Department have their medical consultants, but any information on the matter has not been passed on to us, not being considered to come within our field of operations.

Mr. SCOTT: On the question of the practicability of using one house in a terrace as a shelter, a little more than six months ago I made a similar proposal to the London Trades Council, and suggested that it might be possible to construct a ground floor or semi-basement shelter in one house in every five or six as the circumstances demanded. There are, however, so many difficulties of ownership involved that we as architects cannot dictate the policy. What we can do, and what we will be only too pleased to do, as a profession will be to render the technical advice which is necessary if the owners can agree among themselves, or if the central and local authorities provide the necessary legislation. It is an obvious solution, but we can only provide the technical part of it.

Question: Is the result of blast to cause doors and windows to fall inwards or outwards?

Mr. SCOTT: Experiments have been carried out at Shoeburyness, and in some cases the windows or window-frames have gone in and in others they have come out. In some cases some of the panes have gone in and some have come out. We cannot say, therefore, what is likely to happen. I am not enough of a scientist to tell you why some go in and some come out. The suction wave which follows the initial blast is not of such great intensity but it is of much longer duration, and that probably accounts for the fact that so frequently doors and windows fly out instead of in.

It may be of interest that some of the forms of shelter to which Mr. Bird has referred are being installed at the Building Centre.

Question: You have said that with mechanical ventilation you can employ a filter which will prevent any known poisonous gas from entering. Is it possible to use the same filter with an ordinary extract system without mechanical means?

Mr. SCOTT: No, because if you are extracting air it means that it is finding its own way in, and what it is necessary to do in a ventilated shelter is to filter the air as it comes in. If you have inlets and the air is not filtered when it finds its way in it may bring poison gas with it. The only form of mechanical ventilation which can be applied to a shelter without filtering is one in which the air intakes are so high that they are above the vertical range of a poison gas cloud, but you cannot be sure of that because the intake shaft may be damaged by a splinter, and then if there is gas about it will be drawn into the shelter.

The Conference adjourned at 12.45 p.m. until 2 p.m.

FOURTH SESSION

15 JUNE 1938, AT 2 p.m.

CONSIDERATION OF A.R.P. REQUIREMENTS IN SPECIAL TYPES OF BUILDING

Mr. E. L. BIRD: This afternoon I propose to deal with special types of building, and you will appreciate that the points which I wish to make will be mainly supplementary to those which we have discussed already as being generally applicable to all types of building. Consideration of special buildings is to some extent tied up with public policy, as, for example, in regard to schools, theatres, etc. As we have had no final decisions on that yet, I can only indicate certain possibilities in such cases.

In dealing with buildings as types we have to consider great variations in structure and planning; for example, factories may be of the horizontal north light roof type or of the multi-floor type; a factory may have a free space all round it or it may be in a congested area; similar variations are found in the case of schools. In the case of flats, the construction may differ, framed construction being used for large flats in the West End of London and non-framed in typical tenements. Those points must be borne in mind when we are discussing different types.

Again, I suggest that it is necessary to consider in each case the vulnerability of the particular building, which will be another factor. A hospital in the middle of a city, for example, is in a very different A.R.P. position from one in an outer residential suburb.

Schools

In the typical elementary school the classrooms do not lend themselves for conversion into shelter accommodation; I think we can establish that quite definitely at the beginning. That is mainly because the window areas are large and tend in new buildings to become even larger. On the other hand, some of the older schools, and some of the secondary and technical schools and boarding schools, usually contain certain rooms, other perhaps than classrooms, of a more substantial construction, with smaller windows than are usually provided in the classrooms. In the main, however, we can consider that the school is a very difficult type in which to provide shelter accommodation for the occupants.

There is also a tendency in school buildings, and particularly with State-aided schools, to reduce construction to the finest limits to secure economy in first

cost. Assuming the schools to be in use during war-time, we are therefore faced first with the question of providing trenches in the case of either existing or new buildings where the land permits—as I suggest it will in the great majority of suburban schools, and particularly the new ones, where education authorities make a point of having abundant playing fields attached to the schools—or finding some other method of protection.

A suggestion made for new schools by the Structural Precautions Committee was as follows. It was noticed in examining several types of new school that the cloak-room and locker and lavatory accommodation were often planned in the form of semi-detached wings. It occurred to us that such a block might readily be strengthened structurally by giving it walls which were resistant to splinter effect and to the lesser blast effects, and a concrete roof which would keep out " bits " and the lighter incendiary bombs. It might be necessary, and would be desirable, to place the windows high up, or to reduce them considerably in area. We know that it is all against ideas of sanitation to reduce the window area, but I do suggest that under modern sanitary conditions with impervious surfaces we could do with a good deal less window area in cloakrooms and lavatories than we normally have. They are not places which are occupied for any length of time.

Factories

There are four principal considerations with regard to factories : the protection of personnel ; the protection of machinery and the localisation of damage ; the protection of stores and the localisation of fires ; the prevention of total disorganisation by damage to plant. It is obvious that if a bomb is dropped on the nerve centre of the building, it is a much more important matter than if it falls on one of several duplicated shops.

The first question is one of layout. Large factories should, where possible, be planned as a series of separate units, and these units should, where possible, be self-contained with the necessary power plant, or the power plant and other vital services should be duplicated. The buildings should not be arranged in a straight line. Since that recommendation was made I have seen published in an English aeronautical paper photographs of an aircraft factory in Germany where this principle has been adopted. The shops there are mainly assembly units and manufacturing units, and they consist of steel-framed buildings covered with light sheeting, which will fly off under blast effects and be easily repairable. The units are staggered about a very large site and are connected by roads. Each of those assembly shops has a concrete shelter for the personnel in the basement, and altogether the factory affords quite a poor target.

In new buildings it may be possible to plan large single-floor workshops with sufficient space between plant—this is a matter for the clients—to make it possible to build sandbag or brick division walls, screening walls which will serve to protect the machinery from horizontally flying splinters. They will not do more than that, and they are not intended to ; they are not intended to localise the blast of a direct hit by a large bomb in the shop itself, but to afford a certain amount of protection to the machinery. The sandbag walls should be about 3 feet thick and will therefore take up considerable room in the gangways, and it will be an important point for the building owner to consider whether he should afford the space.

In the case of north light roofs and roof lights it is possible to use wired glass, which will give a better degree of resistance than ordinary cast glass. Alternatively, if it is proposed to keep the factory going during war-time, and particularly if it is working at night on munitions, the glass might be taken out on the outbreak of war and the roof boarded up. It would mean working entirely by artificial light but would get over the difficulty of screening the light from aircraft at night, and it must be borne in mind that it may be necessary to do this for some hours when aircraft are about. I am thinking more particularly of the Midland manufacturing areas. There may be a preliminary warning from the South-East Coast, a warning for the London area and a standby warning for the Midland area, but the aircraft may never come to the Midland area at all, yet the factory may be shut down for four or five hours. Boarding up the roof is worth the consideration of a manufacturer who wishes to keep going as long as possible. I do not think that there is much else which can be done in the case of a north light roof. It has been suggested that certain forms of netting might be suspended underneath the roof to catch glass splinters, but the glass will fall only once and it is probably better to board the whole place up and use artificial light.

Then there is the question of stores. Normally all buildings used as stores, particularly for inflammable material, will require special protection, and should have a solid reinforced concrete roof sufficient to keep out the incendiary bomb. There is a special type of lantern light, where lantern lights are necessary, which may be considered, and it is shown in the accompanying diagram. It has the glass surfaces vertical,

and not horizontal or sloping. I would also like to suggest that a great many storage buildings often have more window space than is strictly necessary.

The nerve centres of the factory, such as the power-house and the telephone exchange, require special consideration. You have in the ordinary power-house

a good deal of potentially destructive machinery, steam-pipes, etc., which may cause considerable trouble if hit by splinters. They should be designed in new buildings with fairly solid walls to afford protection against blast and splinters.

Another point is the question of fire in factories, particularly where there are inflammable materials, and it is suggested that provision should be made at suitable points in large factory rooms for the accommodation of fire-watchers. In the corner of a large workshop which contains inflammable material there should be a small shelter for a fire-watcher. It should have narrow slit windows through which the watcher can see the whole of the factory or floor. Such shelters may in multi-storey buildings be vertically over each other and connected with a cat ladder. They should, of course, have telephone connection to the fire brigade or to the works telephone exchange and to the factory fire patrol, if one is organised. That provision for fire-watchers will occur to you in connection with other types of buildings than factories where inflammable material is stored or used.

With regard to shelters, their provision will be difficult in the case of certain factories in congested areas. Where there is an open space you can provide trench shelters, which will probably be as good as anything in the case of the vulnerable single-floor north light roof type of building which has very thin walls. There are various alternatives. One suggestion is that under shops there may be large pipe tunnels which contain the various services to the machines. Such a tunnel might conceivably be designed as a shelter with a sufficiently thick concrete roof over it, or it might be used as a means of access to shelters in bays going off each side of the tunnel. It has the disadvantage that it is necessary to consider what types of service are going through the tunnel, because such things as steam pipes might be dangerous. I suggest that if you do use that form of shelter special provision should be made for shutting off the mains before they come into the tunnel.

Another suggestion is the duplication of power plants and services and the protection of services by taking them underground with a concrete slab over, instead of, as in so many factories, slinging them overhead on steel gantries.

In certain types of factory building where there are stores adjacent to shops, it may be possible to plan the stores as traverses to break up the area of the shop. That depends very largely, of course, on the particular process carried out in the factory.

There is in existence a handbook, No. 6, dealing with factories and business premises, but it was issued some time ago. There is some useful information in it, particularly with regard to shelters, but we have progressed a little since it was issued and when you read it you should bear that in mind.

Departmental Stores and Shops

Here we have another very wide range of type from the very big multi-floor steel-framed drapery store down to the small single room shop. I propose to deal more with the larger type than with the smaller. The things to consider in particular are the protection of the personnel, which includes in the case of most large stores a great number of women—I believe some employ more than a thousand ; in the great majority of town stores it is very difficult to find a suitable place to put them, because the basement is often used as a public shop. Another point to consider is the question of the prevention of looting, which is a matter of some importance to the client when his windows are broken, and we should remember that his steel shutters will probably be broken as well.

Another point is the protection of foodstuffs, and yet another the inflammability of the contents of the store. Obviously a big drapery store has a high fire risk.

In new buildings I would suggest the provision of a roof sufficient to keep out light incendiary bombs, the avoidance of high architectural features above the roof, and other considerations of that type which we have already referred to for multi-storey buildings generally. If it is possible to provide a portion of the basement or of an upper floor as a staff refuge room, obviously the floor over that should be designed for the demolition load. In most cases in large store buildings the staircases will have to be considered as the most likely places for staff shelters, and it is possible that clients may consider using part of their basements for the same purpose. With the large store having an open basement there are usually certain private portions which are not open to the public—stockrooms and so on—which are customarily built in fairly light construction. They might reasonably be built in a stronger form of construction and entirely artificially lit. Obviously each store must be considered on its merits.

I should like to repeat a suggestion which I made at the Inaugural Meeting of this Conference with regard to a wall at the back of the display space as a protection against blast, splinters and looting. The great majority of large stores employ artificial light almost the whole time, and behind the display windows they have light panelling which may or may not extend to the whole height of the window. Since the shop is to be lit by artificial light, that panelling might well be replaced by a fairly strong wall. It would have to have doors in it for access to the window space, but it would give very considerable protection to the ground floor and might make the ground floor a very useful shelter for the staff as well as for any shoppers who were on the premises at the time of a raid. If the wall were in reinforced concrete it could be homogeneous with the floors above and below, but if of brickwork it might have to be carried down to a good bearing in the basement.

In considering an air raid precaution scheme for an existing building, some sort of provision for closing the ordinary glass doors, which might be destroyed, should be made beforehand by the clients. It should not be difficult to arrange for some form of wooden shuttering which could be erected by the staff carpenters.

Warehouses

In warehouses we are dealing not with the problem of protecting personnel so much as with the problem of protecting goods, and there is a very high fire hazard in a great many cases, and a fire hazard which extends to neighbouring buildings as well as to the building itself. The old solid-wall type of warehouse, the typical type with quite thick walls and a light pitched roof, will withstand blast and splinter effects fairly well, but an incendiary bomb may come through the roof and set it alight, and the fire will spout out at the top. Those of you who have seen a warehouse well ablaze will appreciate what sort of a volcano it can be. In providing a reinforced concrete roof on the top, therefore, you not only protect the building against the damage done by light incendiary bombs in the warehouse itself, but you prevent the fire to some extent from spreading to other buildings. You will appreciate that with a 6-inch concrete roof, a 25-lb. or 50-lb. incendiary bomb might go through, but, even if it set the interior on fire, there would be a fairly considerable fire stop on the top of the building for some time.

Again, I would suggest the necessity for fire-watchers, the need for reduction in window space and for full fire-resisting construction. Many old warehouses have not that construction. A common one is an interior of steel or cast iron columns supporting heavy timber joists. In such a case it is possibly worth while considering, not the reconstruction of the whole warehouse, but the putting of a reinforced concrete roof on the top.

Cross-walls will also greatly assist in preventing the spread of fire, and I should regard the London Building Act regulations in that respect as a minimum. Where a group of warehouses is close to a canal or river, it may be worth while making some provision for a water supply for fire-fighting from that source, to guard against the possible failure of the street mains. One way which has been suggested, and which I believe is being carried out in one instance, is the making of small canals or trenches which are covered over, leading to little access holes into which the suction hose of a fire engine can be put.

Offices

We have discussed the question of offices a good deal already. The first consideration is shelter accommodation for personnel; others are the fire hazard of the roof; the question of glass roofs, particularly over large general offices; alternative means of escape, which is important where you have shelter accommodation on an upper floor; avoiding placing large safes in the middle of the floor panels, and in new buildings either providing strong rooms in the basement, or giving safes a proper bearing on the framework. In the case of banks and premises containing valuable documents, the provision of metal grilles to the ground floor windows to prevent the possibility of looting should be considered.

One member of the Conference has asked me to say something more about the possibility of protecting pavement lights and bulkhead lights with sandbagging, where that is possible. It is certainly possible to provide a certain measure of protection to a basement with a pavement light by strutting the latter suitably and piling earth or sandbags—the earth need not be in sandbags—on the top. I do not suggest that it is as good as solid construction, but it should be quite reasonable.

Flats and Tenements

We have already discussed this matter, but I have a few suggestions to make other than those which have already been put forward. If a basement were provided for the whole of a tenement scheme it is conceivable that such a shelter could be used by the local authority as a public shelter for persons living in the neighbourhood in poor quality houses. In existing buildings it is possible that refuge accommodation might be made out of the staircases and landings. Also where there is a private balcony, with the kitchen and bathroom on the inside, the latter might be used as a family shelter. In the ordinary tenement building this provides about as good a shelter as can be obtained on the upper floors; the lobby or hall might be included.

It is suggested that the shelter accommodation in large housing schemes might include first aid posts. Some housing schemes have populations which are rather larger than a good many villages and both a first aid post and a decontamination centre might well be included.

We suggest that air bricks and larders should be capable of being easily closed to prevent the contamination of food by gas.

In the case of a large commercial scheme, part of the basement may be utilised as an air raid shelter. The shelter provided should in such cases obviously be away from the central heating boiler-house, and should have good alternative exits. Such a basement space might be used in peace-time as a communal recreation room or as a tenants' store room where they can keep their spare furniture, trunks, etc. Re-entrant spaces on plans having wings could also be used, and this applies to some extent to office buildings also. Such spaces may be used in offices as document stores, or in flats as private store rooms for tenants. They need have no windows and a little strengthening would make them available as refuge accommodation.

Places of Entertainment

Here again public policy governs A.R.P. considerations. Since theatres, cinemas and concert halls are

one-cell buildings containing a large number of people, they are particularly vulnerable. I suggest that staff shelters might be contrived either on the emergency stairs of theatres, which are fairly well protected, or possibly under the sloping floor of the auditorium, which the local authority, at any rate in most cities, usually requires to be of fire-resisting construction. Heavy plant at roof level is undesirable ; many theatres put their fans and fan gear on the roof.

Hospitals

I now come to the exceedingly difficult and complicated subject of hospitals. There is to be issued, I understand, in the course of a few weeks a special pamphlet on hospitals, and therefore I do not propose to say much about the matter now. The hospital building is in use in war-time and you cannot move the occupants to shelter. I suggest that attention should be paid to the following points :—

(*a*) Fire-resisting construction and concrete roof.

(*b*) Sill levels.

(*c*) The possibility in multi-floor hospitals of putting the administration on the ground floor and the ward floors over, so as to place them above the worst splinter effects.

French windows appear to be undesirable, but can be provided with some degree of protection if there is a terrace outside, as there commonly is, by providing that terrace with a solid parapet wall, which is a form of screening for the window.

The question of providing mechanical input ventilation for wards and kitchen should be considered. Many hospitals have a ground floor kitchen with a roof light over it ; also the flues cause a strong current of fresh air into the room, making gas-proofing almost impossible. It seems sensible, therefore, to take the air supply to the kitchen in from a place where it will not be contaminated by poison gas, namely, by means of a high-level protected shaft with an opening in the vertical face of a wall, and a fan. That would also tend to prevent the contamination of food, and indeed I am thinking more of that than of the safety of the people working in the kitchen, who could wear gas masks for a short time if necessary. A mechanical input ventilation system to wards should also be considered.

A point to suggest to clients in A.R.P. schemes is that with a corridor plan having small wards on each side containing either a single bed or from two to four beds—and wards of this type are now fairly common—in time of war it would be worth while pulling the beds against the inner wall. That would give the patients more protection than if they are nearer the windows. It is a small point, but it may not occur to the hospital authorities unless it is pointed out.

With regard to operating theatres, the old partial top light and wall window is obviously exceedingly vulnerable, and it is not possible to use an operating theatre which has a window of that type with any degree of security. There are various suggestions for the adaptation of existing theatres of this type. One is to take this type of window out and put in a window in the vertical wall only, such as a large number of operating theatres already possess. Another is to earmark some specially protected basement space as an emergency war-time operating theatre, which would mean, however, operating away from all the theatre sterilising apparatus. It is also worth remembering that many surgeons definitely like working by artificial light. In considering the protection of the vertical window in the theatre wall, there is usually a balcony outside for access to the air filtering apparatus and for window cleaning. On this balcony it might be possible to build up some form of protection for the window ; alternatively you might take the glass out, board up the window, and let the surgeon use artificial light. In many cases a particular surgeon's decision will be final.

If the operating theatre is anywhere but fairly high up the extract ventilation system will draw in gas. Considerable structural alterations would be required to place a filter suitably, and it should be remembered that extract plants not only tend to suck through the grids which are provided for them but also under doors. It would be much better if the system could be reversed in some way so as to make it an input system drawing air in through a filter and forcing it into the theatre, but I admit that that is not an easy problem, at least in old operating theatres.

Other Buildings

The Committee considered many other types of building, such as hotels, museums, libraries, churches, public-houses and restaurants, but I think I have said enough this afternoon about special types. One type of building to which I should like to make brief reference, however, is the municipal building and the police building. They are to some extent in the same category as the hospital, in that the rooms will have to be used during air raids. Various precautions will suggest themselves to you at once—the protection of the telephone system, for instance, is an obvious necessity, as is also the provision of a certain amount of protected office accommodation in which men can sit at the telephone and work at their desks with some degree of security. In police stations, and possibly in municipal buildings also, the provision of large rooms, preferably in the basement, is desirable for parade purposes and collecting people together—wardens, police, fire-fighting squads, etc. If the existing telephone switchboard is not suitably protected, an alternative is to provide a protected emergency switchboard in the basement with all important telephone lines connected to it.

Small Houses

I want to deal with the question of small houses mainly from the point of view of new buildings. The Sub-Committee made several suggestions, some of which

are incorporated in the handbook. To deal first of all with the walls, 9-inch and 11-inch walls will obviously not give a particularly good degree of protection, although they will give some. The resistance of the outer walls to blast pressure may be increased by judicious buttressing of cross-walls. The carrying up in terrace houses of the party wall to the under-side of the roof gives stiffening to the roof construction and in particular to the chimney stacks, as well as tending to prevent the spread of fire.

There are several other points to be mentioned, such as the desirability of placing upper floor partitions over ground floor partitions. Unsecured partitions are not safe. Widely projecting eaves may catch the upward effect of blast. Protection against incendiary bombs and gas has been referred to.

It has been suggested that in new houses a specially protected room might be provided. If you were designing that from the beginning, the kind of thing that you would go for, I think, would be first of all the overhead protection. Even a thin reinforced concrete roof or upper floor will keep out " bits." In a protected room it would be better to have a solid floor below than a floor with air bricks, as the latter is difficult to gas-proof. It should also be without a flue, because a flue induces a draught even when there is no fire. I suggest that such a room should have a 13½-inch outside wall, if possible, and 9-inch inner walls, if possible. Those dimensions in practice will often come down to 11 inches and 4½ inches. It should be large enough to accommodate the five or six members of the average household. The window should be of the smallest size consistent with adequate lighting and ventilation and should have a high sill. If the frame is on or near the outside of the wall, you can pile earth in bags on the window-sill to increase the height of it. There should be as few doors as possible. It would also be desirable to have the stopcocks and the main electric light switch and the gas control in or near this particular room. The provision of a water supply in the room is desirable.

I suggest that for people who are building houses in vulnerable areas those simple precautions are not out of the way in a new building ; they do not strike me as particularly expensive, and you can provide yourself in that way with a " better 'ole " than just building the room in the ordinary way and then wishing that the walls of the shelter room had been made of brickwork instead of breeze concrete slabs.

The meeting was then thrown open to questions.

A Member : Taking it for granted that the saving of lives is of greater importance than the saving of buildings, structural A.R.P. work appeals to me in the following order of importance : (1) to devise emergency structures for protecting those whose activities necessitate congregating in large numbers ; (2) to augment the protection of those who may be in existing structures between emergency conditions ; (3) to advocate means of protecting buildings. The Committee have given the last two considerable attention, but the first does not appear to have attained quite the same success. The subject of establishing emergency safety centres for large numbers of people is a very important one, and requires a solution commensurate with its importance.

It seemed to me that at the Inaugural Meeting, Mr. Ansell indicated what is the essence of the solution, namely, to disperse and to get underground. I put forward a suggestion for attaining these objectives in the hope that it will inspire someone to produce a better one. In the last war, for the protection of the troops, deep trenches of great length were constructed, and the men entered them in detachments at many accesses and were dispersed in them and went underground. We can go down to a depth below that of the services, and then with 3 feet of concrete, 4 feet of sand, and a further 5 feet of concrete, as Mr. Scott suggests, we can provide ample underground safety centres, with the necessary refinements of food storage, and so on.

To allot safety stations to the people and to decide the distances between them is merely a matter of organisation. Technical difficulties would arise in plenty, but I am sure that we could overcome them all. I suggest that this would give something permanent in the manner which has been recommended, and would also help property owners who are either unable or unwilling to invest money in such protection.

Answer : Your remarks are more a matter of public policy for the authorities than for us. Architects will design such places readily if they are asked to do so. But I do not know that necessarily the suggestion can come from us except in so far as a copy of these proceedings will be studied by the A.R.P. Department.

Question : A few weeks ago a report was issued by the French Government to all their local authorities and engineers, and was published in the various technical papers in France. They have the same outlook as we have in that they cannot promise to protect anyone from a direct hit, but they make a definite recommendation about the spacing between walls and certain protective slab thicknesses worked out according to the weight of the building which might fall on top of them. What is interesting, however, is that they insist on having the walls of places where people will shelter of as dense a material as possible, and they go so far as to recommend that the inside surface of the wall should be waterproofed, not to keep water from seeping into the structure, but so that humidity in the atmosphere, instead of being absorbed by the wall, will be condensed thereon, thus removing the humidity out of the atmosphere and reducing the temperature. That recommendation has also been made in Germany.

Answer : I agree that that is a good point. What you want seems to be quite the opposite from ordinary building construction, where you want walls which are heat-retaining or have low thermal conductivity. You want something with high thermal conductivity. Concrete has that, and I suggest that a basement shelter built of concrete in earth would transmit heat quite rapidly from the surface outwards, and therefore have a cold inner surface. The water might run down the walls and on to the floor, but you would have to put up with that.

Question : I am surprised that there has been no mention of the use of 6-foot diameter concrete pipe as a shelter, and also of the use of 2-foot diameter concrete sewer pipe as a crawling way for alternative means of escape from a basement.

Answer : You will see types of large pipe intended for use as shelters in the exhibition at the Building Centre which has

been referred to, or, at any rate, there will be illustrations of them. I am glad that that point has been raised.

Question : Has the problem been solved of making a public garage suitable as a paying proposition and also as a shelter ?

Answer : I think that the multi-floor garage without windows might provide in its basement a shelter suitable for use in time of war, and this would be preferable to the underground type of garage. Possibly the storerooms round the sides might be so planned that they could be used as shelters. With a framed building over such a basement, and no windows, there would be good protection against direct hits, and there would have to be thick floors to take the load of motor cars, as well as moderately thick walls. The general idea of digging holes in the London squares and putting garages underneath them which could be converted into air raid shelters is not, I think, feasible.

Question : There seems to be some confusion on the question of the lining of shelters. We have been told that a non-absorbent surface is the right one, but information was given which was diametrically opposed to that.

Answer : What you have to do in a shelter is to get rid of the moisture exhaled in the breath and from the skin. The way hitherto recommended by the A.R.P. Department, based on long and elaborate research not merely in the laboratory but also with people, is that as great an absorbent area as possible should be provided to remove this moisture, which comes into the air. The alternative has been suggested this afternoon of purposely condensing it, which is another method of doing the same thing, and might be worth trying.

Question : Are not there chemicals procurable for dealing with this problem of the air, as in the case of submarines ?

Answer : Yes, but it is suggested that the method is too complicated for air raid shelters.

Question : Would the introduction of cylinders of oxygen be of any use ?

Answer : I think so.

Question : Apart from laboratory tests, are there any data derived from a direct hit on buildings or shelters ?

Answer : It has been very difficult until recently to get any data of the effect of a direct hit on a properly constructed shelter, because though large numbers of shelters have been built in Spain, and large numbers of bombs dropped, no shelter received a direct hit. I believe that one has occurred in the last week or two, and I think I have read that the shelter resisted the shock except that a few small lumps of concrete were spalled off inside the shelter.

Question : Do you think that reinforcement of the Hy-rib type would stop concrete falling off on the under-side ?

Answer : Any close mesh reinforcement on the under-side would help to do that.

Mr. SCOTT : But it must not be too close, creating a clearly defined plane in the concrete, as the concrete might split along such a plane. The best reinforcement is something which is very fine, with small bar members at right angles, of small section.

A Member : At a certain R.E. depot in France during the last war there was a factory which made burster slabs, and expanded metal lathing was once used for reinforcing these. The expanded metal lathing was of too fine a mesh, and simply caused the thing to split in two ; instead of acting as a reinforcement it made a weak plane on which it split.

Question : Would you consider the covering of an existing timber floor over a basement with sandbags to avoid putting in a concrete floor, shoring the floor before doing so ?

Mr. SCOTT : A timber floor over the basement could not be expected to do more than, if suitably strutted, resist demolition effects.

The Questioner : I come from the City, where we have many hundreds of basements of that character. Private owners cannot take up all these floors and put in concrete ones, and if the floors could be shored up and covered with sandbags it might be possible to provide accommodation for the thirty or forty people who occupy the premises.

Mr. SCOTT : The sandbags would not serve any purpose. Lateral protection against blast and splinters will be provided by the earth if the shelter is below ground, and I do not think the sandbags are necessary. Really satisfactory strutting of the floor itself at close intervals would probably be sufficiently effective in the normal way against demolition.

Question : Would it be relevant to draw attention not only to the question of thicknesses of concrete but to the quality of concrete ? There are members here who are not architects, and it might be useful to draw attention to the fact that workmanship plays a very large part in securing good results.

Answer : I quite agree that concrete should be properly proportioned and made under proper conditions.

Question : You have referred to 9 inches of concrete, but you have given no idea of the sectional area of reinforcement required.

Mr. SCOTT : I am not going to give an exact answer because I do not think there is one. So far as the proportion of reinforcement is concerned, speaking from an A.R.P. point of view alone, it is the considered opinion of the chief technical officer of the research department at Woolwich, that so long as the concrete for walls is of good quality reinforcement does not help very much in resisting the penetration of splinters. He has declared that he would prefer a good concrete without reinforcement to resist the penetration of splinters, but, of course, if you are considering a very large area of wall, you will need at least a normal amount of reinforcement. I cannot be more exact in the case of floors, because it is extremely difficult, if not impossible, to determine the exact amount of reinforcement to use. I would only say that it is better to use small sections than large sections, and it is better to use small sections of reinforcement in both directions, certainly on the under-side of a floor slab, because any heavy blow on the upper surface might tend to spall off large chunks from the under-side.

Question : Would you advocate the use of round bars in preference to any other section ?

Mr. SCOTT : I think that if the section is small, it does not matter whether they are round bars or indented bars, or what they are. You want small members at close intervals instead of large members at wide intervals.

Question : I understand that in Germany it is compulsory to embody some provision for air raid protection in all new buildings. I should like to ask whether it is thought desirable that that should be the case in this country.

Answer : I believe that is so, and that it is now compulsory in new buildings in Germany to embody, at any rate, an air raid shelter, and a decree has been issued to that effect. I believe there is some financial rebate. But that is a matter for the Government, and not for us.

Question : I have been struck by the difference of opinion on the time which will be available for making preparations in the event of an emergency.

Answer : No one can give a definite answer, but it is

suggested that there may be some period of tension which may last perhaps the most four days, and it is also considered that if we can get through the first month of hostilities and mobilise our immense resources, we shall probably weather the storm.

Mr. SCOTT : If the point is when precautions which may be looked on as emergency precautions, such as the digging of trenches and so on, should be carried out, the answer is that we are gathered here as a conference of architects to advise our clients and assist them, if possible, in incorporating as permanent measures in buildings such structural precautions against air raids as can be devised. Those which cannot be incorporated in new buildings or devised as permanent structural measures in existing buildings, have to be carried out at some time which will be for our clients to decide.

Question : Have you any evidence of the effect, if any, of light steel reinforcement in brick walls, particularly against lateral pressure, and what support will it give in the event of loss of supporting columns ?

Answer : Reinforcing of brickwork is a new science, and not yet general practice. I should think a brick wall reinforced with bars would be more resistant to blast pressure than one not reinforced.

Vote of Thanks

Mr. HUBERT WORTHINGTON [*F.*] : I do not think this Conference should come to an end without someone in a formal way thanking the lecturers for the marvellous way in which they have dealt with this subject. I have come here as an ordinary practising architect, and I came full of doubts and feeling that it might be a waste of time but, in fact, I have learned a very considerable amount. Foch was fond of saying that the principles of war are simple but their applications are difficult, and that certainly applies to what we have been here to study. We should be especially grateful to Mr. Scott and Mr. Bird for having kept to the principles and for not allowing the squibs which we have thrown at them to divert them from their main object. We are practising architects, and it is for us to apply these principles. It will be extremely difficult to do so, but they have given us a really good start off. They have not allowed us to be confused by masses of scientific data much of which might be irrelevant.

There is one thing which does not concern Messrs. Scott and Bird, but is a point which was raised at the Inaugural Meeting by Mr. Caröe, namely, what we as architects are to do. Those who are aid raid officers know what to do, but the ordinary architect requires to be given a lead by someone. In the beginning of the War in 1914 I wanted to serve my country, and I wrote to the War Office and asked whether I could join the Royal Engineers, because I had a certain amount of technical knowledge, but in fact I was sent into the P.B.I. and remained there until the end of the War. If a war in the air is going to come, I do not want to serve in a dressing station as an orderly. I feel that the country ought to make use of its technical experts, and if there is going to be an air war, the architect is going to be invaluable ; the country will not be able to do without him, and therefore someone should get busy—whether it be this Institute or whether it be the Home Office—and tell the architects as a body all over the country how they should act as salvage people, because any city architect will tell you that he cannot cope with all that will have to be done if real trouble comes.

I should like to express the very great gratitude which we all feel to Mr. Scott and Mr. Bird for a very fine performance.

ENGINEER REAR ADMIRAL A. VERNON SHARPE, R.N. (retd.) : As a humble A.R.P. officer, I should like to be allowed to second the vote of thanks on my own behalf and on behalf of all the A.R.P. officers present. We have had a most interesting two days, and I have learned a great deal. We are most grateful for all the information which we have been given.

(*The vote of thanks was carried with prolonged applause.*)

Mr. T. E. SCOTT : We appreciate very much the kind things which Mr. Worthington and the seconder have said, and the way in which they have been received. I am not going to pretend that this A.R.P. work which we have been doing for the last three years has been altogether a holiday ; it has been extremely difficult to see through the mass of information which we have had, and the sometimes confusing reports which we have received from various authorities, but we have been able to make some progress, and it is very gratifying to feel that the work of those years has now reached this climax, that at last we have been able to get together a conference of architects, a group of architects who really want to learn something about this rather unpleasant but very necessary subject.

Mr. Worthington raised a point to which I meant to refer, when Sir Samuel Hoare was here at the Inaugural Meeting, in reply to Mr. Caröe. He has touched on a problem of air raid precautions which may be just as important as the one which we are considering now. The scanty evidence which we have had from Spain does indicate that thousands of poor people have lost their lives through the demolition of buildings, and you have all seen in the daily newspapers photographs of buildings in ruins which were reported still to contain the bodies of those who were sheltering in the basement, or even live people. It seems to me if a building is in a state of collapse, dealing with it is no task for an unskilled man ; it would be nothing less than fatal to turn loose about fifty hearty strong men to pull it to pieces, and an architect is better qualified than any other man to know just what to touch and what not to touch to prevent, if possible, the further collapse of the building. I should like to think that what Mr. Worthington has said this afternoon will start some movement for the proper organisation of the architectural profession throughout the country, so that if an emergency should ever arise their services will be immediately available to take charge of what I believe are termed in official circles " demolition squads."

Incidentally, Leeds has already organised its architectural profession, and I understand that quite a number of the architects in Leeds have volunteered for and have been detailed for that very duty. It is not the sort of task that one would normally expect to be left to the personal direction of an A.R.P. officer. The A.R.P. officer is expected by many people to be a sort of Pooh-Bah, and to know everything about air raid precautions, and to direct every conceivable service. Many of the necessary services do, of course, demand a very high degree of technical, medical, or some other knowledge plus organising ability, and I agree with Mr. Worthington that here, at any rate, we have the sort of problem that an architect can tackle, and in the architectural profession we have a service of which a wise Government will make proper use.

I can only promise you that I shall endeavour after this meeting to bring the matter to the notice of such authorities as may be able to organise the whole profession.

The Conference then terminated.

APPENDIX

NOTES ON THE STRUTTING OF WOODEN JOISTED FLOORS FORMING THE CEILINGS OF PROTECTED ACCOMMODATION*

It is assumed this protected accommodation is on the lowest floor of the building.

The "superimposed loads (additional to the normal loading) are calculated as follows :

(*a*) Framed buildings.

The superimposed load for each superficial foot of floor area (irrespective of the number of floors over) should be 200 lbs.

(*b*) Unframed buildings.

(i) 200 lbs. per superficial foot for 2 floors over.

(ii) 300 lbs. per superficial foot for 3 or 4 floors over.

(iii) 400 lbs. per superficial foot for more than 4 floors over.

The scantlings of timber required in strutting are given in the following table. The floor joists are assumed to be not more than one foot apart. It is most important that the head piece 'D' should be fixed at right angles to the floor joists over. (See Fig. 1.)

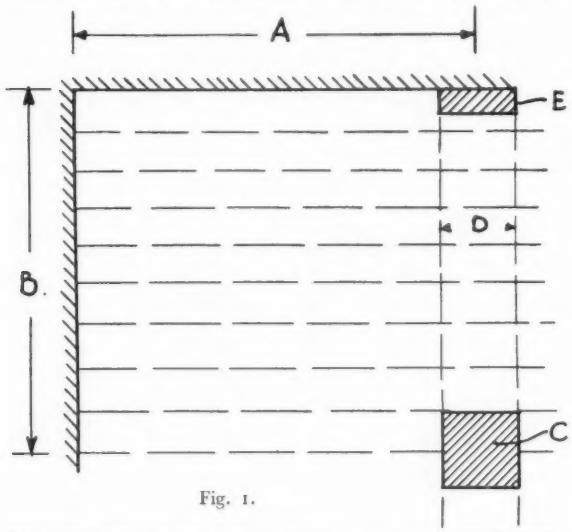


Fig. 1.

Superimposed Loads.	A	B	C	D	E	
		Rooms 10 to 12 ft. high with 11″ × 2″ floor joists over.				
200 lbs....	10′ 0″	10′ 6″	6″ × 6″	2/12″ × 4″	6″ × 4″	The head piece "D" should be two 12" × 4", fixed on edge as sketch.
300 lbs....	10′ 0″	9′ 4″	8″ × 8″	2/12″ × 4″	8″ × 4″	
400 lbs....	10′ 0″	8′ 0″	8″ × 8″	2/12″ × 4″	8″ × 4″	
		Rooms 10 to 12 ft. high with 9″ × 2″ floor joists over.				
200 lbs....	8′ 0″	7′ 0″	6″ × 6″	9″ × 4″	6″ × 4″	The head piece "D" should be fixed on edge.
300 lbs....	6′ 0″	5′ 10″	6″ × 6″	9″ × 4″	6″ × 4″	
400 lbs....	6′ 0″	4′ 8″	6″ × 6″	9″ × 4″	6″ × 4″	
		Rooms 8 to 10 ft. high with 9″ × 2″ floor joists over.				
200 lbs....	7′ 0″	8′ 0″	5″ × 5″	9″ × 4″	5″ × 3″	The head piece "D" should be fixed on edge.
300 lbs....	6′ 0″	5′ 10″	5″ × 5″	9″ × 4″	5″ × 3″	
400 lbs....	6′ 0″	4′ 8″	6″ × 6″	9″ × 4″	6″ × 4″	
		Rooms 8 to 10 ft. high with 7″ × 2″ floor joists over.				
Number of floors over.		(Applicable to Domestic Buildings.)				
1 or 2	5′ 0″	4′ 8″	4″ × 4″	6″ × 3″	4″ × 3″	The head piece "D" to be fixed on edge.
3 or 4	4′ 0″	4′ 8″	4″ × 4″	6″ × 3″	4″ × 3″	

* Prepared by the Air Raid Precautions Department of the Home Office. Similar notes for other types of floor are in course of preparation.

When the strut 'C' rests on a joisted floor it should be fixed on to a continuous floor piece about 2 ins. wider than the strut, and 4 ins. thick. This floor piece should run at right angles to the joists under, and where possible the strut should be arranged immediately above a sleeper wall, but the dimensions given in columns A and B must not be exceeded without a corresponding strengthening of C, D, and E.

Figs. 2 and 3 indicate convenient methods of fixing the strut to the head and sole piece :

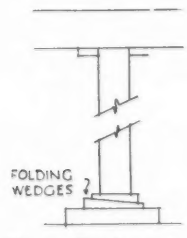


Fig. 2.—For domestic buildings.

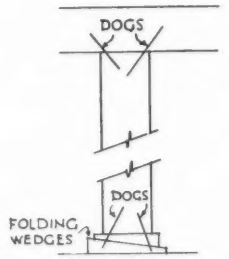


Fig. 3.—For buildings other than domestic.

Review of Periodicals

Attempt is made in this review to refer to the more important articles in all the journals received by the Library. None of the journals mentioned are in the Loan Library, but the Librarian will be pleased to give information about price and where each journal can be obtained. Members can have photostat copies of particular articles made at their own cost on application to the Librarian.

Normally the journals referred to in this review, all of which are in the R.I.B.A. reference library, cannot be borrowed. Members are, however, asked to encourage their local public libraries and their local society's library to take as many journals as they can afford; and they are asked, for the convenience of local members, to notify the R.I.B.A. of what journals are known to exist in public or private hands in their own neighbourhood.

SCHOOLS

R.I.B.A. JOURNAL. *1938. 13 June. P. 744.*
Open air school, Swinton and Pendlebury, Lancs., by Hubert Bennett [*A.*]. An interesting building for 135 children, including nursery accommodation. Three sides of each classroom are of glazed sliding doors. Steel *Diagrid* roof on stanchions with timber walls.

BAUKUNST (BERLIN). *1938. June. P. 185.*
A new school in Berlin by Karl Bonatz.

LABORATORIES

BYGGMÄSTAREN (STOCKHOLM). *1938. No. 16. P. 158.*
State bacteriological laboratories. Some good modern brick buildings described and fully illustrated by E. G. Asplund.

MUSEUMS

BOUWKUNDIG WEEKBLAD ARCHITECTURA (AMSTERDAM). *1938. 14 May. P. 161.*
New art gallery at Basle by R. Christ and Paul Bonatz.

NUESTRA ARQUITECTURA (BUENOS AIRES). *1938. April. P. 131.*
Municipal art gallery at Rosario.

LIBRARY

BUILDER. *1938. 10 June. P. 1133.*
The Harold Cohen Library, University of Liverpool, by H. A. Dod [*F.*].

INSTITUTIONAL

APXNTEKTYPA (MOSCOW). *1938. No. 4. P. 45.*
The Marx-Engels-Lenin Institute at Thilissi by A. V. Shoussev.

RADIO

ARCHITECTURAL FORUM (NEW YORK). *1938. June. P. 454.*
Columbia Broadcasting Studios, Hollywood, an outstanding modern building by William Lescaze.

CIVIC

ARCHITECTS' JOURNAL. *1938. 9 June. P. 993.*
Fire brigade headquarters, Brighton, by G. I. C. Highet.

PRISONS

ARCHITEKT S.I.A. (PRAGUE). *1938. No. 5. P. 73.*
Large prison at Marseilles by G. Castel.

ARQUITECTOS (LISBON). *1938. April. P. 77.*
An article on prison planning.

OFFICES

ARCHITECTURAL REVIEW. *1938. June. P. 295.*

BUILDER. *1938. 10 June. P. 1137.*
Offices in Charing Cross Road by A. Mather and H. W. Weedon [*F.A.*].

ARCHITECTURAL REVIEW. *1938. June. P. 296.*
Council offices adjoining Chesterfield Town Hall, by Houfton and Kington [*L.*].

DESIGN AND CONSTRUCTION. *1938. June. P. 223.*
Reference section on offices and factories. Dean Bradley House, Westminster, by Wimperis Simpson & Guthrie [*FF.*], and an excellent modern administrative building in Basle are among examples illustrated; many good factory buildings are also included, together with an article by R. O. Sutherland [*A.*] on lighting offices and factories.

SHOPS

ARCHITECTURAL FORUM (NEW YORK). *1938. June. P. 497.*
Planning technique for men's shops. A useful reference.

INDUSTRIAL

JOURNAL OF THE TOWN PLANNING INSTITUTE. *1938. May. P. 230.*
Notes on segregation in industry, with special reference to trading estates, by W. G. Holford [*A.*].

TRANSPORT

L'ARCHITETTURA ITALIANA (TURIN). *1938. No. 4. P. 122.*
The magnificent new station at Trento by Angiolo Mazzoni.

BAUWELT (BERLIN). *1938. 16 June. P. 10. Inset.*
Examples of Service stations on the new German roads.

WELFARE

ARCHITECT AND BUILDING NEWS. *1938. 17 June. P. 338.*
The Bristol Blind Asylum. Assembly room, library and work rooms, by R. C. James and H. E. Meredith [*F. & L.*].

COMMUNITY

CONSTRUCTION MODERNE (PARIS). *1938. 5 June. P. 444.*
A social centre at Chateauroux providing, in one large building, for health, education and leisure. Architect, J. Barge.

HOSPITALS, ETC.

ARCHITECT AND BUILDING NEWS. *1938. 10 June. P. 294.*
Extensions to the Redhill County Hospital, Edgware, by W. T. Curtis [*F.*]. The new buildings include Gatehouses, Assistant M.O.'s hostel, extension to nurses' home, a maternity and a chronic block, and an X-ray and out-patients' department.

CHANTIERS (ALGIERS). *1938. April. P. 161.*
Dispensary at Souma. An interesting modern building by A. Bettoli.

SPORTS

BUILDER. *1938. 10 June. P. 1135.*
Kingstanding swimming baths, Birmingham, by Cherrington and Stainton [*FF.*].

A.R.P.

ARCHITECTS' JOURNAL. *1938. 16 June. P. 1017.*
Aerial bombardment, effects and defence. An account by F. Skinner [*A.*] of his recent observations in Barcelona.

DESIGN AND CONSTRUCTION. *1938. June. P. 218.*
Civil Defence—V. The need for large scale planning for communities.

The Annual Election of the Council

THE SCRUTINEERS' REPORT

TO THE CHAIRMAN OF THE GENERAL MEETING
MONDAY, 20 JUNE 1938

The Scrutineers appointed to count the votes for the election of the Council for the Session 1938-1939 beg to report as follows :—

2,499 envelopes were received—593 from Fellows, 1,340 from Associates and 566 from Licentiates.

Of the above totals, seven envelopes—2 from Fellows and 5 from Associates—were invalid, having been posted after the last day for the receipt of envelopes.

The result of the election is as follows :—

COUNCIL 1938-1939

PRESIDENT

Mr. Harry Stuart Goodhart-Rendel (unopposed)

PAST PRESIDENTS

Mr. Percy Edward Thomas (Cardiff) (unopposed)
Sir Raymond Unwin (unopposed)

MEMBERS OF COUNCIL

Elected		Votes
1.	Professor Leslie Patrick Abercrombie	996
2.	Mr. George Grey Wornum	974
3.	Mr. Edwin Stanley Hall	966
4.	Mr. George Noel Hill	806
5.	Mr. Edwin Paul Wheeler	792
6.	Mr. Arthur Charles Bunch	734
Not Elected		Votes
7.	Mr. Charles Herbert Aslin	696
8.	Professor Albert Edward Richardson	681
9.	Mr. Leo Sylvester Sullivan	680
10.	Professor Stanley Davenport Adshead	629
11.	Mr. William Henry Ansell	589
12.	Mr. Percy James Bartlett	573
13.	Mr. John Murray Easton	553
14.	Mr. John Henry Forshaw	447
15.	Mr. Sidney Harold Loweth	418
16.	Mr. Henry V. Ashley	374
17.	Mr. Serge Chermayeff	364
18.	Mr. Gilbert Mackenzie Trench	361
19.	Mr. Arthur Hamilton Moberly	264
20.	Mr. Stanley Churchill Ramsey	261
21.	Mr. Kenneth Mervyn Baskerville Cross	250
22.	Mr. John Swarbrick	248
23.	Mr. Bernard Michael Ward	223
24.	Mr. Victor Bain	200
25.	Mr. John Stuart Syme	149
26.	Mr. Clement Stretton	143
27.	Mr. Ernest Brander Musman	139
28.	Mr. Thomas Wallis	113
29.	Mr. Henry Richard Collins	111
30.	Mr. Samuel Douglas Meadows	71

2,492 Voting Papers were received, of which 18 were invalid.

ASSOCIATE MEMBERS OF COUNCIL

Elected		Votes
1.	Professor William Graham Holford	753
2.	Mr. William Naseby Adams	713
3.	Mr. Wesley Dougill	625
Not Elected		Votes
4.	Mr. John Harrison	547
5.	Mr. Edgar Gooding Catchpole	533
6.	Mr. Richard Alfred Hardwick Livett	525
7.	Mr. Edward Brian O'Rorke	433
8.	Mr. Basil Robert Ward	424
9.	Mr. James Thomas Castle	388
10.	Mr. Russell Thomas Francis Skinner	376
11.	Mr. Colin Troughton Penn	343
12.	Mr. Joseph Stanley Allen	284
13.	Mr. Williiam John Durnford	260
14.	Mr. Johnson Blackett	178
15.	Mr. Walter Goodesmith	173
16.	Mr. Derek Lawley Bridgwater	155
17.	Mr. Thomas Scott Barnes	133

2,492 Voting Papers were received, of which 19 were invalid.

LICENTIATE MEMBER OF COUNCIL

Elected		Votes
1.	Mr. Sidney Lunn Whitehouse	444
Not Elected		Votes
2.	Mr. Percy John Waldram	435
3.	Mr. Roger Davys Manning	365
4.	Mr. Raymond Walker	326
5.	Mr. Louis Blanc	278
6.	Mr. William Walter Begley	198
7.	Mr. Ernest Ashworth	148
8.	Mr. Gordon Herbert Griffiths	73
9.	Mr. Frederick Herbert Field	40

2,492 Voting Papers were received, of which 25 were invalid.

REPRESENTATIVES OF ALLIED SOCIETIES IN THE UNITED KINGDOM OR THE IRISH FREE STATE

(1) *Six Representatives from the Northern Province of England :*

Mr. George Hall Gray (Northern Architectural Association).
Mr. William Albert Johnson (Manchester Society of Architects).
Mr. Harold Alfred Dod (Liverpool Architectural Society).
Mr. Charles William Cashmore Needham (York and East Yorkshire Architectural Society).
Mr. Frederick Lawrence Charlton (West Yorkshire Society of Architects).
Mr. William George Davies (Sheffield, South Yorkshire and District Society of Architects and Surveyors).

(2) *Five Representatives from the Midland Province of England :*

Mr. Samuel Nathaniel Cooke (Birmingham and Five Counties Architectural Association).
Mr. Edward John Williams (Leicester and Leicestershire Society of Architects).

Major Basil Charlton Deacon (Northamptonshire, Bedfordshire and Huntingdonshire Association of Architects).
Mr. William Gregory Watkins (Nottingham, Derby and Lincoln Architectural Society).
Mr. Leslie Barefoot (East Anglian Society of Architects).

(3) *Six Representatives from the Southern Province of England :*
Mr. John Clayton Collingwood Bruce (Devon and Cornwall Architectural Society).
Mr. Charles William Pike (Wessex Society of Architects).
Mr. George Hastwell Grayson (Berks, Bucks and Oxon Architectural Association).
Mr. Arthur Leonard Roberts (Hampshire and Isle of Wight Architectural Association).
Mr. Hugh Patrick Guarin Maule (Essex, Cambridge and Hertfordshire Society of Architects).
One representative to be nominated by the Council of the South-Eastern Society of Architects.

(4) *Four Representatives of Allied Societies in Scotland*, nominated by the Council of the Royal Incorporation of Architects in Scotland :—
Mr. Norman Aitken Dick (Glasgow).
Colonel George Gardner McLean (Glasgow).
Mr. Charles Geddes Soutar (Dundee).
One more representative to be nominated by the R.I.A.S.

(5) *One Representative of Allied Societies in Wales*, nominated by the Council of the South Wales Institute of Architects :—
Mr. Oliver Spencer Portsmouth (Swansea).

(6) *Two Representatives of Allied Societies in Ireland :—*
Mr. Harry Allberry (Royal Institute of the Architects of Ireland).
One Representative to be nominated by the Council of the Royal Society of Ulster Architects.

REPRESENTATIVES OF ALLIED SOCIETIES IN THE BRITISH DOMINIONS OVERSEAS

To be nominated by the Councils of each of the following :
The Royal Architectural Institute of Canada.
The Royal Australian Institute of Architects.
The New Zealand Institute of Architects.
The Institute of South African Architects.
The Indian Institute of Architects.

REPRESENTATIVE OF THE ARCHITECTURAL ASSOCIATION (LONDON)
Mr. Verner Owen Rees.

REPRESENTATIVE OF THE ASSOCIATION OF ARCHITECTS, SURVEYORS AND TECHNICAL ASSISTANTS
Mr. Roderick Charles Fisher.

CHAIRMAN OF THE BOARD OF ARCHITECTURAL EDUCATION
Mr. Hubert Lidbetter.

CHAIRMAN OF THE R.I.B.A. REGISTRATION COMMITTEE
Mr. Thomas Arthur Darcy Braddell.

CHAIRMAN OF THE R.I.B.A. OFFICIAL ARCHITECTS' COMMITTEE
REPRESENTATIVE OF THE R.I.B.A. SALARIED MEMBERS' COMMITTEE
CHAIRMAN OF THE ALLIED SOCIETIES' CONFERENCE, VICE-PRESIDENT
Mr. James Robertson Adamson.

HONORARY AUDITORS
Mr. Robert William Pite (unopposed).
Mr. James Maclaren Ross (unopposed).

ERNEST G. ALLEN (Chairman).
J. D. HOSSACK.
D. H. BEATY-POWNALL.
ROBERT W. PITE.
RONALD TOPHAM.
CECIL H. PERKINS.

We regret that owing to the length of the Air Raid Precautions Conference it is not possible to publish Book Reviews, Correspondence, Obituaries, etc., in this number of the Journal.

Membership Lists

ELECTION : 20 JUNE 1938

In accordance with the terms of Byelaws 10 and 11, the following candidates for membership were elected at the Council Meeting held on Monday, 20 June 1938.

AS HON. CORRESPONDING MEMBER (1)

MAGINNIS : CHARLES DONAGH, LL.D. ; President of the American Institute of Architects.

AS FELLOWS (9)

EAST : HERBERT SPRINGFORD [*A.*1892], Launceston, Tasmania.
HOWES : JAMES FREDERICK [*A.* 1929].
JACKMAN : FRANK LEONARD [*A.* 1927].
NISBET : ALEC [*A.* 1920], Oxford.
SHOOSMITH : ARTHUR GORDON, O.B.E. [*A.* 1918].
THREADGOLD : ROBERT AINSLIE [*A.* 1922], Liverpool.

And the following Licentiates who have passed the qualifying Examination :—

EATON : FRANCIS OWEN, Port Elizabeth, S. Africa.
WHEATLEY : WILLIAM BAILEY, Hull.

And the following Licentiate who is qualified under the provisions of Section IV, Clause 4 (*c*) (ii) of the Supplemental Charter of 1925 :—

NUNWEEK : ARTHUR, Sheffield.

AS ASSOCIATES (20)

AUSTIN : ROBERT PRIESTLEY [Passed five years' course at the Birmingham School of Architecture. Exempted from Final Examination], Birmingham.
BRENCHLEY : BASIL EDWARD [Passed five years' course at the School of Architecture, The Polytechnic, Regent Street, London. Exempted from Final Examination].
BUBB : EDWARD CAVENDISH [Final].
COOPER : CHRISTOPHER HAROLD [Passed five years' course at the Liverpool School of Architecture, University of Liverpool. Exempted from Final Examination], Bury, Lancs.
COOPER : LESLIE LIONEL [Passed a qualifying Examination approved by the Institute of South African Architects], Port Elizabeth, S. Africa.
EVANS : RONALD WYNN [Final].
FAIRTLOUGH : ANDREW CHARLES, M.A.(Cantab.) [Passed five years' joint course at the School of Architecture, University of Cambridge and the Architectural Association. Exempted from Final Examination].
HIRST : THEODORE JAMES [Passed five years' course at the Architectural Association. Exempted from Final Examination].
JANKS : BERNARD [Passed a qualifying Examination approved by the Institute of South African Architects], Johannesburg, S. Africa.
LUNTZ : ABRAHAM [Passed five years' course at the Liverpool School of Architecture, University of Liverpool. Exempted from Final Examination], Johannesburg, S. Africa.
MORRIS : DESMOND RUPERT [Passed five years' course at the Architectural Association. Exempted from Final Examination].
MOSS : JOHN [Special Final Examination], Jerusalem, Palestine.

ORTTEWELL : Miss RICHENDA [Passed five years' course at the Architectural Association. Exempted from Final Examination], Swanage, Dorset.

RATCLIFF : JOHN CLIFFORD [Passed five years' course at the Architectural Association. Exempted from Final Examination].

RICHARDS : EDWIN HODDER [Final], Foleshill, Coventry.

SHARKEY : EDMOND PATRICK [Passed five years' course at the School of Architecture, Robert Gordon's Colleges, Aberdeen. Exempted from Final Examination].

SUMMERS : NORMAN [Passed five years' course at the Architectural Association. Exempted from Final Examination].

WALTHO : GEOFFREY [Passed five years' course at the Birmingham School of Architecture. Exempted from Final Examination], Tettenhall, Staffs.

WILLIAMS : ARTHUR CHARLES [Final].

WOODHOUSE : Miss BEATRICE ETHEL LIVESEY [Passed five years' course at the Liverpool School of Architecture, University of Liverpool. Exempted from Final Examination].

AS LICENTIATES (10)

BENNETT : WALTER ROBERT FRANCIS.

CLARKE : WILLIAM GEORGE, Sheffield.

DICK : DOUGLAS LOUIS KNOWLES.

FISHER : FREDERICK REGINALD.

GOODFELLOW : ROBERT DAVIDSON, Edinburgh.

HEATH : SAMUEL TITLEY, Wigan.

JONES : LEONARD STANLEY.

LUXTON : ARTHUR CHASTEY, Exeter.

ROISER : ERNEST ALFRED, Cheltenham.

TROWER : FRANK, Worthing.

ELECTION : 18 JULY 1938

In accordance with the terms of Byelaws 10 and 11, an election of candidates for membership will take place at the Council Meeting to be held on Monday, 18 July 1938. The names and addresses of the candidates, with the names of their proposers, found by the Council to be eligible and qualified in accordance with the Charter and Byelaws are herewith published for the information of members. Notice of any objection or any other communication respecting them must be sent to the Secretary R.I.B.A. not later than Thursday, 7 July 1938.

AS FELLOWS (6)

ASHWORTH : HENRY INGHAM [*A.* 1929], 6 Raymond Buildings, Gray's Inn, W.C.1 ; Bartlett School of Architecture, University College, London ; 3 Stapenhill Road, North Wembley, Middlesex. Proposed by Professor A. E. Richardson, H. Lidbetter and L. Sylvester Sullivan.

BUTTON : EUSTACE HARRY, A.R.W.A. [*A.* 1924], 18 Orchard Street, Bristol, 1 ; 4 Canynge Road, Bristol 8. Proposed by G. D. Gordon Hake, C. F. W. Dening and B. F. G. Wakefield.

And the following Licentiates who have passed the qualifying Examination :—

ELDRED : HERBERT SYDNEY GUILDFORD, Borough Surveyor's Office, Town Hall, Rochdale ; 6 King's Hey Drive, Hesketh Park, Southport. Proposed by C. Gustave Agate and the President and Hon. Secretary of the Manchester Society of Architects under the provisions of Byelaw 3 (*a*), and applying for nomination by the Council under the provisions of Byelaw 3 (*d*).

JONES : COLIN LANCELOT, County Hall, Newport, Mon. ; "Whitewalls," 53 Alteryn Close, Newport. Proposed by Percy Thomas, T. Alwyn Lloyd and Henry Budgen.

THOMPSON : BRUCE DERMOTT, 83 Bridge Street, Worksop, Notts ; 77 Sparken Hill, Worksop. Proposed by Harry B. S. Gibbs, J. Amory Teather and W. Geo. Davies.

WALTERS : EDWARD JOHN, 28 Great Ormond Street, W.C.1 ; 64 Madeira Avenue, Bromley, Kent. Proposed by Sydney Tatchell, R. Mountford Pigott and Thos. Wallis.

AS ASSOCIATES (15)

BESWICK : ROBERT EASTCOTT EDWARD [Passed five years' course at the Liverpool School of Architecture, University of Liverpool. Exempted from Final Examination]. 10 Victoria Road, Swindon, Wilts. Proposed by A. E. Beswick, William G. Newton and Professor Lionel B. Budden.

BLAIR : DONALD LANSDOWNE, B.Arch., A.M.T.P.I. [Passed five years' course at the School of Architecture, McGill University, Montreal. Exempted from Final Examination], London House, Guilford Street, W.C.1. Proposed by Howard Robertson, L. H. Bucknell and P. J. Westwood.

COUSINS : FRANK WALTER [Passed five years' course at the Architectural Association. Exempted from Final Examination], 121 Pollards Hill South, Norbury, S.W.16. Proposed by G. Grey Wornum, R. Furneaux Jordan and G. Alan Fortescue.

EDWARDS : STRACEY ALLAN [Passed five years' course at the Architectural Association. Exempted from Final Examination], 37 Broadfield Road, Folkestone. Proposed by R. Furneaux Jordan and the President and Hon. Secretary of the Architectural Association under the provisions of Byelaw 3 (*b*).

GARTON : ARTHUR ERNEST JAMES, B.A.Cantab. [Passed five years joint course at the School of Architecture, University of Cambridge and the Architectural Association. Exempted from Final Examination], 16 Kemplay Road, N.W.3. Proposed by F. W. Halfhide, R. John O'Donoghue and S. E. Dykes Bower.

HITCH : RICHARD ALSTON BROOK [Passed five years' course at the Architectural Association. Exempted from Final Examination], 2 Dean Bradley Street, Westminster S.W.1. Proposed by Evelyn Simmons and the President and Hon. Secretary of the Architectural Association under the provisions of Byelaw 3 (*b*).

HODGE : FRANK STANLEY [Special Final Examination], 422 Upper Richmond Road, Putney, S.W.15. Proposed by E. Vincent Harris, Sir Giles Gilbert Scott and Horace Farquharson.

MACKAY : JAMES CAMPBELL, Dip.Arch. (Glasgow) [Passed five years' course at the Glasgow School of Architecture. Exempted from Final Examination], "Aviemore," Hillock, Polmont, Stirlingshire. Proposed by T. Harold Hughes, A. N. Malcolm and William J. Smith.

MCQUEEN : ALASTAIR NORMAN LEIGH [Final], Roughhills, Dalbeattie, Scotland. Proposed by Martin S. Briggs, Professor A. E. Richardson and C. Lovett Gill.

MANSON : BEN MURRAY, Dip.Arch.(Edinburgh) [Passed five years' course at the School of Architecture, Edinburgh College of Art. Exempted from Final Examination], 32 Almond Bank Terrace, Edinburgh 11. Proposed by T. Forbes MacLennan, John F. Matthew and F. C. Mears.

MUHR : (Miss) ELSA [Passed five years' course at King's College (University of Durham), Newcastle-upon-Tyne. Exempted from Final Examination], Lyndenhurst, Hutton Avenue, West Hartlepool. Proposed by W. B. Edwards, G. E. Charlewood and Lieut.-Colonel A. K. Tasker.

OGILVIE : JOHN [Passed five years' course at the School of Architecture, Edinburgh College of Art. Exempted from Final Examination], c/o Renton, 106 Thirlestane Road, Edinburgh. Proposed by A. F. Balfour Paul, F. C. Mears and T. Aikman Swan.

SAUNDERS : JOHN GOWER [Passed five years' course at the Architectural Association. Exempted from Final Examination], Field End Lodge, Eastcote, Middlesex. Proposed by Lieut.-Colonel B. Culmer Page, Noel D. Sheffield and Val. Bonella.

SHEPHERD : EDWIN [Final], 3 Ashurst Mansions, 90 Nightingale Lane, S.W.12. Proposed by Norman Culley, Joseph Addison and W. T. Curtis.

WINSOR : RONALD LOUIS [Final], 15 King's Road, Fareham, Hants ; Architect's Department, County Hall, Chelmsford. Proposed by A. C. Townsend, Ernest J. Thomas and John Stuart.

AS LICENTIATES (9)

BOUTALL : RICHARD TAUNTON, H.M. Office of Works, Broadway Court, S.W.1 ; 2 Wentworth House, Kingsway, Hove 3, Sussex. Proposed by A. Jessop Hardwick, Stanley F. Anderson and J. S. Kelsall.

FAGG : ERNEST WILLIAM, c/o Edwin A. Jackson, 36 High Street, Hythe, Kent ; 2 Lynton Road, Hythe. Proposed by Edwin A. Jackson and the President and Hon. Secretary of the South-Eastern Society of Architects under the provisions of Byelaw 3 (*a*).

FITZSIMMONS : ARTHUR, Survey House, Brockley Rise, S.E.23 ; 98 Murray Avenue, Bromley, Kent. Proposed by Richard B. Ling, Geo. W. Grey and Louis Jacob.

GOWEN : HARRY JOSIAH THOMAS, Architect's Department, Crown Brewery, King Street, Norwich ; Reedroof, Hillside Road, Thorpe St. Andrew, Norwich. Proposed by F. H. Swindells, Stanley J. Wearing and Eric W. B. Scott.

HARPER : WALTER GEOFFREY, Union Chambers, Temple Row, Birmingham ; 17 Brueton Avenue, Solihull, Warwickshire. Proposed by C. E. Bateman, Alfred Hale and W. Norman Twist.

HARRIS : SIDNEY WESLEY, London County Council, County Hall, S.E.1 ; "Harwyn," 117 Seaforth Gardens, Stoneleigh Hill, Ewell, Surrey. Proposed by E. P. Wheeler, G. Weald and W. T. Sadler.

LAWSON : GEOFFREY FORSYTH, Lincoln Chambers, Market Place, Banbury, Oxon ; 34 Bloxham Road, Banbury. Proposed by Eric Cole and the President and Hon. Secretary of the Gloucestershire Architectural Association under the provisions of Byelaw 3 (*a*).

MILNE-DAVIDSON : MAJOR JAMES MILNE, I.S.O., F.S.A., H.M. Office of Works, Storeys Gate, S.W.1 ; Lynwood, Ashtead, Surrey. Proposed by Sir J. G. West, John H. Markham and Archd. Scott.

WENNING : VICTOR JACQUES, 10 Great James' Street, Bedford Row, W.C.1 ; 43 Goodwyn Avenue, Mill Hill, N.W.7. Proposed by W. E. Trent, William T. Benslyn and W. Sydney Trent.

APPLICATIONS FOR MEMBERSHIP

ELECTION : 24 OCTOBER 1938

In accordance with the terms of Byelaws 10 and 11, an election of candidates for membership will take place at the Council Meeting to be held on Monday, 24 October 1938. The names and addresses of the overseas candidates, with the names of their proposers, are herewith published for the information of members. Notice of any objection or any other communication respecting them must be sent to the Secretary R.I.B.A. not later than Monday, 19 September 1938.

AS FELLOW (1)

WEEKES : BARNET NORMAN [*A.* 1921], 19 O'Connell Street, Sydney, N.S.W. ; 7 Wunulla Road, Point Piper, Sydney. Proposed by Major-General Sir Charles Rosenthal, Henry E. Budden and B. J. Waterhouse.

AS ASSOCIATES (11)

CARVER : HUMPHREY STEPHEN MUMFORD [Passed five years' course at the Architectural Association. Exempted from Final Examination], Lorne Park House, Lorne Park, Ontario, Canada. Proposed by James Macgregor, W. Harding Thompson and Dr. Thos. Adams.

COLLINS : JOHN BARROW, B.A.Arch. [Passed a qualifying Examination approved by the Institute of South African Architects], c/o Divisional Council Building, Stellenbosch, Cape Town. Proposed by Professor L. W. Thornton White, H. J. Brownlee and F. K. Kendall.

EGAN : JOHN EDWARD [Passed a qualifying Examination approved by the Institute of South African Architects], c/o W. H. Grant, Esq., Commercial Union Building, 21 Georges Street, Cape Town. Proposed by H. J. Brownlee, John Perry and Professor L. W. Thornton White.

KNOX : LAURENCE ALEXANDER [Passed a qualifying Examination approved by the Royal Australian Institute of Architects], Department of the Interior, Canberra, F.C.T., Australia ; c/o Commonwealth Bank, Australia House, Strand, London. Proposed by Edwin H. Henderson, B. J. Waterhouse and Henry E. Budden.

KOTASTHANE : KRISHNARAO MORESHWAR [Final], 65 Apollo Street, Fort, Bombay. Proposed by C. M. Master, Burjor S. J. Aga and Pestonji Phirozshah Kapadia.

PARELKAR : KHANDERAO ANANDRAO [Final], "Architectural Studio," Prospect Chambers, Fort, Bombay. Proposed by Frederick McKnight, Burjor S. J. Aga and Pestonji Phirozshah Kapadia.

TROUP : MISS MARGARET MACDONALD [Passed five years' course at the Bartlett School of Architecture, University of London. Exempted from Final Examination], 469 Jorissen Street, Pretoria, South Africa. Proposed by Professor A. E. Richardson, F. W. Troup and applying for nomination by the Council under the provisions of Byelaw 3 (*d*).

WILLIES : WALTER IVOR [Passed a qualifying Examination approved by the Institute of South African Architects], 9-12 Netherlands Bank Buildings, Smith Street, Durban, S. Africa. Proposed by Ernest M. Powers, W. G. Moffat and Wallace Paton.

WILLINGTON : THOMAS HALEY [Passed a qualifying Examination approved by the Royal Australian Institute of Architects], 28 Undercliff Street, Neutral Bay, N.S.W. Proposed by Professor Alfred S. Hook, Arthur Wm. Anderson and Edwin Hubert Henderson.

WILLIS : GEORGE M., Dip.Arch.(Cape Town) [Passed a qualifying Examination approved by the Institute of South African Architects], "Allambic," Newlands Road, Claremont, Cape Town, S. Africa. Proposed by Professor L. W. Thornton White, John Perry and F. K. Kendall.

ZAMMIT : ARTHUR JOHN [Passed five years' course at the Bartlett School of Architecture, University of London. Exempted from Final Examination], 86 John Barbara Street, Hamrun Street, Malta. Proposed by Professor A. E. Richardson, H. O. Corfiato and L. Stuart Stanley.

Notices

ROME SCHOLARSHIP IN ARCHITECTURE

EXHIBITION OF FINAL COMPETITION DESIGNS

The designs submitted in the Final Competition for the Rome Scholarship in Architecture will be on exhibition in the Henry Florence Hall between the hours of 10 a.m. and 8 p.m. (Saturday, 10 a.m. and 5 p.m.) from 5 to 9 July 1938, inclusive.

The Scholarship is provided by the R.I.B.A., which makes a grant of £750 a year to the British School at Rome. It is awarded by the Faculty of Architecture of the British School at Rome, and is keenly contested annually by the most brilliant students in the country. The scholar is required to go to Rome to study for a period of two or three years at the British School at Rome.

This year the subject for the competition was "A Play Park." Thirteen students, from the following schools, were admitted to the competition :

The School of Architecture, Cambridge University.
The Welsh School of Architecture, The Technical College, Cardiff.
The School of Architecture, Edinburgh College of Art.
The Liverpool School of Architecture, University of Liverpool.
The Bartlett School of Architecture, University of London.
The School of Architecture, The Victoria University, Manchester.
The School of Architecture, King's College, University of Durham, Newcastle-upon-Tyne.
The Department of Architecture, University of Sheffield.

Competitions

The Council and Competitions Committee wish to remind members and members of Allied Societies that it is their duty to refuse to take part in competitions unless the conditions are in conformity with the R.I.B.A. Regulations for the Conduct of Architectural Competitions and have been approved by the Institute.

While, in the case of small limited private competitions, modifications of the R.I.B.A. Regulations may be approved, it is the duty of members who are asked to take part in a limited competition to notify the Secretary of the R.I.B.A. immediately, submitting particulars of the competition. This requirement now forms part of the Code of Professional Practice in which it is ruled that a formal invitation to two or more architects to prepare designs in competition for the same project is deemed a limited competition.

ADWICK-LE-STREET: NEW COUNCIL OFFICES

The Urban District Council of Adwick-le-Street invite architects whose offices are situated in the West Riding of Yorkshire to submit in competition designs for new Council Offices.

Assessor: Mr. John C. Procter, M.C. [*F.*].

Premiums: £50, £40 and £30.

Last day for submitting designs: 30 August 1938.

Last day for questions: 23 April 1938.

Conditions of the competition may be obtained on application to Mr. C. R. Marshall, Clerk to the Adwick-le-Street Urban District Council, Bank Chambers, High Street, Doncaster. Deposit £1 1s.

BRIERLEY HILL, STAFFS.: NEW MUNICIPAL BUILDINGS

The Brierley Hill Urban District Council invite architects of British nationality to submit in competition designs for new Municipal Buildings.

Assessor: Mr. Verner O. Rees [*F.*].

Premiums: £250, £150 and £100.

Last day for submitting designs: 30 November 1938.

Last day for questions: 30 June 1938.

Conditions of the competition may be obtained on application to Mr. F. Oakes, Clerk to the Brierley Hill U.D.C., Council Offices, Moor Street, Brierley Hill, Staffs. Deposit £2 2s.

ILKESTON: BATHS, GYMNASIUM AND FIRE STATION

The Council of the Borough of Ilkeston invite architects of British nationality to submit, in competition, designs for a Community Centre, comprising Public Baths and Gymnasium, and for a Fire Station.

Assessor: Professor Lionel B. Budden [*F.*]

Premiums: £200, £100 and £50.

Last day for submitting designs: 14 September 1938.

Last day for questions: 14 June 1938.

Conditions of the competition may be obtained on application to the Town Clerk, Town Hall, Ilkeston. Deposit £1 1s.

METROPOLITAN POLICE STATION, MARYLEBONE ROAD

The Receiver for the Metropolitan Police District invites architects of British nationality and resident in the United Kingdom to submit in competition designs for a new Police Station proposed to be erected on a site in Marylebone Road.

Assessors: Mr. G. Mackenzie Trench, O.B.E., F.S.I. [*F.*].
Mr. S. Rowland Pierce [*F.*].

Premiums: £300, £200 and £100.

Last day for submitting designs: 12 August 1938.

Last day for questions: 1 June 1938.

Conditions of the competition may be obtained on application to the Receiver for the Metropolitan Police District, New Scotland Yard, London, S.W.1. Deposit £1 1s.

NEWCASTLE-UPON-TYNE: NEW TOWN HALL

The Council of the City and County of Newcastle-upon-Tyne invite architects of British nationality to submit in competition designs for a new Town Hall.

Assessor: Mr. Verner O. Rees [*F.*].

Premiums: £750, £500 and £300.

Last day for submitting designs: 30 November 1938.

Last day for questions: 6 July 1938.

Conditions and instructions to competitors, together with a site plan, may be obtained on application to Mr. John Atkinson, Town Clerk, Town Hall, Newcastle-upon-Tyne. Deposit £2 2s.

ST. GEORGE'S HOSPITAL: RECONSTRUCTION

The President, Vice-President, Treasurer and Governors of St. George's Hospital invite architects practising in the United Kingdom and Northern Ireland to submit in competition designs for the reconstruction of St. George's Hospital, Hyde Park Corner.

Assessors: Dr. H. V. Lanchester [*F.*].
Mr. T. A. Lodge [*F.*].

Premiums: £500, £300 and £200.

Last day for submitting designs: 30 August 1938.

Last day for questions: 1 March 1938.

Conditions of the competition may be obtained on application to The House Governor, St. George's Hospital, Hyde Park Corner, London, S.W.1. Deposit £2 2s.

YEOVIL: NEW TOWN HALL AND MUNICIPAL BUILDINGS

The Yeovil Borough Council invite architects to submit in competition designs for new town hall, municipal offices, public library and museum.

Assessor: Mr. C. Cowles-Voysey [*F.*].

Premiums: £200, £150, £100 and £50.

Last day for submitting designs: 30 June 1938.

Last day tor questions: 15 March 1938.

COMPETITION FOR TWENTY HOUSES ON THE KINGSTON BY-PASS

Messrs. Wates, Ltd., invite architects of British nationality to submit in competition designs for a development scheme for twenty houses in a prominent position on the Kingston By-pass, New Malden, Surrey.

Assessors: Mr. Louis de Soissons, O.B.E. [*F.*]

Mr. C. H. James, A.R.A. [*F.*].
A Director of Messrs. Wates, Ltd.

Prizes : £75, £50 and £25.
The successful architect will be paid in addition the R.I.B.A. scale fee up to £65.
Last day for receiving designs : 18 July 1938.
Last day for questions : 4 June 1938.
Conditions of the competition may be obtained on application to Messrs. Wates, Ltd., 1258-1260 London Road, Norbury, London, S.W.16.

COMPETITION FOR DESIGNS FOR BRICK FIREPLACES OR FIRE SURROUNDS

Messrs. Dunbrik, Ltd., invite architects and architectural students in Great Britain to submit in competition designs for five fire-places and surrounds.

Assessors : Mr. Howard Robertson [*F.*].
Mr. G. A. Jellicoe [*F.*].
Mr. Brian O'Rorke [*A.*].

Premiums : £50, £25 and £10.
Last day for sending in designs : 31 July 1938.
Conditions of the competition may be obtained on application to Messrs. Dunbrik Ltd., 46-47 Chancery Lane, London, W.C.2.

FORTHCOMING COMPETITIONS

Other competitions which it is proposed to hold, and the conditions for which are not yet available, are as follows :—

BRIGHOUSE : NEW MUNICIPAL BUILDINGS
Assessor : Mr. James R. Adamson [*F.*].

COSELEY, STAFFS : NEW SCHOOL
Assessor : Mr. A. C. Bunch [*F.*].

EDMONTON : NEW TOWN HALL BUILDINGS
Assessor : Mr. E. Berry Webber [*A.*].

GODALMING : NEW MUNICIPAL BUILDINGS
Assessor : Mr. Stanley C. Ramsey [*F.*].

GLOUCESTER : NEW SWIMMING BATH AND FIRE STATION
Assessor : Mr. C. F. W. Dening, R.W.A. [*F.*].

METROPOLITAN EAR, NOSE AND THROAT HOSPITAL : RECONSTRUCTION
Assessors : Messrs. Charles Holden [*F.*] and Lionel G. Pearson [*F.*].

OLDHAM : ELECTRICITY OFFICES AND DEPARTMENTAL BUILDINGS
Assessor : Professor R. A. Cordingley [*F.*].

SHREWSBURY : NEW SENIOR SCHOOL
Assessor : Mr. C. Cowles-Voysey [*F.*].

SOUTH SHIELDS : ASSEMBLY HALL AND LIBRARY
Assessor : Mr. Arthur J. Hope [*F.*].

WREXHAM : NEW TOWN HALL
Assessor : Mr. Herbert J. Rowse [*F.*].

COMPETITION RESULT
TIMBER COTTAGE DESIGNS

1. Messrs. C. R. Crickmay [*A.*] and H. W. Crickmay [*A.*] (Weymouth).
2. Mr. H. St. John Harrison [*F.*] (London).
3. Mr. H. J. W. Broadwater [Student] (Stanmore, Middlesex).

Special Mention Awards :—
Miss Beryl Bickerton [*A.*] and Mr. Brian E. Wood [*A.*] (London).
Messrs. Godman and Kay [*FF. & A.*] (Horsham).
Mr. J. D. Maidment and Mr. E. Vernon Knott [*A.*] (Sheffield).
Mr. J. W. Davidson [Student] (Sheffield).
Mr. Stanley E. Burden [Student] (Oxford).
Mr. G. G. Pace [Student] (Croydon).

MEMBERS' COLUMN

Owing to limitation of space, notices in this column are restricted to changes of address, partnerships vacant or wanted, practices for sale or wanted, office accommodation, and appointments vacant. Members are reminded that a column in the Advertisement Section of the Journal is reserved for the advertisements of members seeking appointments in architects' offices. No charge is made for such insertions and the privilege is confined to members who are definitely unemployed.

NEW PARTNERSHIP

Mr. Thos. S. Tait and Mr. Francis Lorne [*FF.*] announce that they have taken into partnership Mr. L. Gordon Farquhar [*A.*]. The firm's name remains as before : Sir John Burnet, Tait & Lorne.

PARTNERSHIPS WANTED

Architect M.A. [*F.*], F.S.I., retiring from active senior partnership abroad, previously in London office, experience in all types of design and structural engineering, desires position with partnership in view. Some capital available. R.A. exhibits ten, competitions won seven. Apply Box 8638, c/o Secretary R.I.B.A.

F.R.I.B.A (41) practising in London desires to purchase partnership in well-established practice in London or country. Suggests amalgamation of practices with capital payment to make up difference. Present practice established 11 years.—Apply Box 2368, c/o Secretary R.I.B.A.

PRACTICE FOR SALE

F.R.I.B.A. desires to retire from practice in prominent rising New Zealand city with country connection and seeks offers of purchase of goodwill. An excellent chance for a young vigorous architect. For particulars apply to Box 9638, c/o Secretary R.I.B.A.

ASSISTANCE OFFERED

A.R.I.B.A. (middle-aged) undertakes part-time work in London area or at home. Schemes worked out or competition work. Many years' experience on commercial and domestic work, and alteration problems. Moderate terms.—Box 1568, c/o Secretary R.I.B.A.

OFFICE ACCOMMODATION TO LET

Half-share of Architect's three-room office available in September ; Great James Street ; £45 p.a.—Apply Box 1468, c/o Secretary R.I.B.A.

Fellow has first-rate principal's room and drawing office for two men (or more) to let in modern building in Westminster. Lifts, porters, heating, cleaning, lighting. £100 a year inclusive. Part-time secretary by arrangement if required.—Box 1058, c/o Secretary R.I.B.A.

OFFICE ACCOMMODATION WANTED

Member requires small office, preferably with use of telephone, in the vicinity of Gray's Inn—Apply Box 2268, c/o Secretary R.I.B.A.

CHANGES OF ADDRESS

Mr. Eric N. Smallwood [*L.*] has changed his address from 46 Farm Road, Edgware, Middlesex, to " Haseldene," Oaks Crescent, Wolverhampton. Telephone : Wolverhampton 21178.

Major Basil C. Deacon [*F.*] has changed his office address to 85 George Street, Luton, Beds. Telephone number remains the same, viz., Luton 168.

Mr. F. Charles Saxon, M.C., F.S.I. [*F.*] has changed his address to 2 Stanley Street, Chester. Telephone number remains the same, viz., Chester 435.

CHANGES OF ADDRESS

MR. DENZIL NIELD [*A.*] has moved from the Outer Temple, 222 Strand, to 11 Gayfere Street, Westminster, where he will carry on the practice of Messrs. G. E. Nield & Son.

FROM 24 June 1938, Mr. C. M. Oldrid Scott, F.S.A. [*F.*], and Mr. Edward Playne [*A.*], will be at 19 Queen Anne's Gate, Westminster, S.W.1. Whitehall 2552.

MR. W. J. WHITESIDE [*A.*], has changed his address to Military Engineer Services, Agra Cantt., U.P., India, and will be pleased to receive trade catalogues.

MINUTES XII

SESSION 1937-1938

At the twelfth general meeting of the session 1937-1938, held on Monday, 20 June 1938, at 8 p.m., Mr. H. S. Goodhart-Rendel, President, in the chair.

The meeting was attended by about 85 members and guests.

The minutes of the one hundred and fourth annual general meeting, held on 9 May 1938, having been published in the JOURNAL, were taken as read, confirmed and signed as correct.

The Hon. Secretary announced the decease of :—

Francis Charles Bayliss, transferred to Licentiateship 1925, Fellow 1925.

John Lancashire, Licentiate 1911, Fellow 1931.

Reginald James Walter Newman, transferred to Licentiateship 1925, Fellow 1925.

Arthur Forman Balfour Paul, M.C., Licentiate 1911, Fellow 1933. Mr. Balfour Paul was a Past President of the Edinburgh Architectural Association, and was a member of the R.I.B.A. Council from 1935-1936.

John Arthur Smith, elected Fellow 1907. Mr. Smith was a Past President of the Hampshire and Isle of Wight Architectural Association, and represented that body on the R.I.B.A. Council from 1927-1931.

Allen Wilson, Licentiate 1911, Fellow 1926.

Walter Dewes, Licentiate 1910, Fellow 1925, Retired Fellow 1931.

Stephen Lewis Wynne Copnall, elected Associate 1935.

James Lindsay Grant, elected Associate 1918.

John Joseph Miller, elected Associate 1886.

Alfred Thomas Martindale, elected Licentiate 1911.

Samuel Edwin Burgess, elected Licentiate 1912, transferred to Retired Licentiateship 1936.

And it was resolved that the regrets of the Institute for their loss be entered on the minutes and that a message of sympathy and condolence be conveyed to their relatives.

The following members attending for the first time since their election were formally admitted by the President :—

Fellows

Raymond Carey — H. S. East

Associates

George Bidwell — I. H. Horsburgh
Miss Helen B. Blaker — Edric Neel
A. H. Brookholding-Jones — D. E. Percival
E. G. J. Chapman — Miss J. Jackson Stops
A. E. Cresswell — C. C. G. Webb

Licentiates

Dudley W. Joel — William Shackell
John R. Smith

The Secretary, having read the report of the Scrutineers on the result of the Annual Election for the Council, the President declared that the President, Members of Council and the Honorary Auditors for the Session 1938-1939 were duly elected in accordance therewith.

On the motion of the President a vote of thanks was passed by acclamation to the Scrutineers for their labours, and was briefly responded to by Mr. Ernest G. Allen [*F.*], Chairman of the Scrutineers.

The formal business of the meeting having concluded, the President invited members to join in a private and informal discussion on subjects of professional interest or difficulty.

The proceedings closed at 9.25 p.m.

It is desired to point out that the opinions of writers of articles and letters which appear in the R.I.B.A. JOURNAL must be taken as the individual opinions of their authors and not as representative expressions of the Institute.

Members sending remittances by postal order for subscriptions of Institute publications are warned of the necessity of complying with Post Office Regulations with regard to this method of payment. Postal orders should be made payable to the Secretary R.I.B.A. and crossed.

Members wishing to contribute notices or correspondence must send them addressed to the Editor not later than the Tuesday prior to the date of publication.

R.I.B.A. JOURNAL

DATES OF PUBLICATION. — 1938 ; 18 July ; 15 August ; 12 September ; 17 October.